SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS
DSS FILE. NO. 05SQ.23440-4-9265

PREPARED FOR

SUPPLY AND SERVICES, CANADA

SUBMITTED BY

ASSOCIATED MINING CONSULTANTS LTD.
WITH
COAL MINING RESEARCH COMPANY

PERMIT TO PRACTICE
ASSOCIATED MINING CONSULTANTS LTD.
Signature
Date DEC 03 1985
PERMIT NUMBER: P 2361
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

DECEMBER 1985

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SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

BY

ASSOCIATED MINING CONSULTANTS LTD
WITH
COAL MINING RESEARCH COMPANY

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Coal Research Laboratory
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CALGARY, Alberta
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Attention: Dr. R. Kolada
Scientific Authority

Dear Sirs:

Re: Survey of Methane Accumulation Within Coal Silos
DSS File No. 05SQ.23440-4-9265
Contract Serial No. 0SQ85-00006

We take pleasure in submitting our final report on Survey of Methane Accumulation Within Coal Silos. We would like to thank CANMET for sponsoring this study and for the advice and guidance during its execution.

Respectfully submitted,

ASSOCIATED MINING CONSULTANTS LTD.

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SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

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THE STUDY TEAM

This survey was carried out by:

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EXECUTIVE SUMMARY

Methane gas is desorbed from coal during and after mining. Since methane forms an explosive mixture with air over a range of concentrations, a hazard can exist in coal storage silos. In Western Canada approximately 30 million tonnes of product will pass through silos each year.

Associated Mining Consultants Ltd., together with the Coal Mining Research Company, conducted tests at eight mines in Western Canada. Desorption rates of thermal and metallurgical coals before and after processing were determined. Methane and oxygen concentrations were measured in the coal silos at the mines, between the silo roof and the surface of the coal pile and below the surface of the coal pile. Analyses were made for the presence of other gases within the coal pile. Measurements were taken as the silos were being filled, with the condition static and as the silos were being discharged. Using the desorption tests, a prediction was made of the methane concentration to be expected in the voids in the coal pile. A comparison was made with the actual concentrations measured.

Concentrations of methane as high as 42% were observed. The desorption tests gave an indication of the likely concentration but variations occurred at each mine and in certain cases for different coals at the same mine.

The survey showed that no general concentration could be taken for coals in Western Canada and each mine requires separate study.

SOMMAIRE

Le méthane est désorbé du charbon pendant et après l'exploration minière. Comme le méthane devient un mélange explosif quand il entre en contact avec de l'air (à des niveaux variés de concentration), un danger existe dans les tours de stockage du charbon. Chaque année, dans l'Ouest du Canada, 30 millions de tonnes de charbon passent dans les installations de stockage.

Associated Mining Consultants Ltd. en collaboration avec Coal Mining Research Company, a effectué des tests dans huit mines de l'Ouest Canadien. Ces derniers ont permis de déterminer le débit de désorption du charbon de chaudière et du charbon de métallurgie avant et après traitement. Des niveaux variés de concentration de méthane et d'oxygène ont été mesurés dans les installations de stockage de charbon de certaines mines, entre le toit de la structure de ciment et le dessus de la pile de charbon et aussi à l'intérieur du tas de charbon. Des analyses ont été faites afin de détecter la présence d'autres gaz à l'intérieur de la pile de charbon. Ces mesures ont été prises soit pendant le remplissage des tours de stockage, soit pendant que le charbon était stationnaire, soit pendant le déchargement des tours de stockage. Ces tests sur le débit de désorption ont permis d'estimer les niveaux de concentration de méthane que l'on peut s'attendre à trouver dans les espaces vides à l'intérieur des piles de charbon. Par la suite, une comparaison des estimations a été faite avec les niveaux réels de concentration du gaz.

Des niveaux de concentration de méthane aussi élevé que 42% ont été constatés. Les tests de désorption ont permis d'estimer les niveaux probables de concentration de gaz mais ceux-ci varient de mine en mine et dans certains cas, ils varient selon la sorte de charbon à la même mine.

Cette étude a démontré qu'il est impossible de déterminer un niveau général de concentration de gaz pour les différents charbons de l'Ouest Canadien et que chaque mine devrait être l'objet d'une étude telle que celle-ci.

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SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 1 - BACKGROUND

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Figure 1-2 Minimum Explosive Concentration of Harbour Seam (No.26) Coal Dust in Methane/Air Mixture

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SECTION 1 - BACKGROUND

1.1 INTRODUCTION

In Western Canada approximately 30 million clean tonnes per year of coal will pass through storage silos, both raw and product. As recent silo designs have catered to dust abatement, there has been a trend away from open to closed topped silos, many with scrubbers to allow air flow without releasing dust to the atmosphere. This also holds true for silo loadouts and conveyor covers, which may trap potentially explosive concentrations of methane.

The aim of this survey is to quantify methane make at a variety of mines in Western Canada, so that the coal operator may better understand the desorption process and apply this knowledge to future and existing designs.

Methane gas is desorbed from coal during and after mining. The rate of desorption is dependent on a number of factors including rank, depth of cover prior to mining, chemical characteristics, physical characteristics, temperature and also the method of processing of the coal. It is known that crushing, processing and thermal drying may increase the desorption rate of methane from coals.

Coal continues to desorb methane when stored in silos. Since methane forms an explosive mixture with air over a range of concentrations, a hazard can exist in coal storage silos. Figure 1-1 shows the inflammability triangle (after Coward) for mixtures of methane, oxygen and nitrogen. The presence of other gases which can be desorbed from coal, can increase the explosive range (1).

The inevitable presence of coal dust in a silo significantly affects the extent of the hazard, since coal dust/methane mixtures in air are explosive even at low methane concentrations (see Figure 1-2 for example) [2].

If coal dust/methane concentrations are within the explosive range combined with a sufficient supply of oxygen, then given an ignition source, an explosion will occur. An explosion occurred in 1982 within a clean coal silo at the Fording Coal Elkford Mine [2], and recently other explosions occurred at the loadouts of two other Western Canadian coal mines.

Normally the ventilation systems installed in coal silos will dilute the methane with air to levels below the explosive range. Care is taken to ensure no unventilated pockets exist where methane can accumulate.

Limited investigations by USBM [7, 8] and CANMET [5, 6] found that ignitable concentrations of methane occur inside the coal pile of both clean and raw coal silos even when well ventilated. The ignitable concentrations were also present to a height of 0.25 m above the coal pile surface in the clean coal silos when they were discharging. This indicated that methane desorbed during storage can build up within the coal pile to explosive levels or above. On discharging the coal, the methane forms a surface layer which is then removed in the ventilation air.

The coal discharged from the silo may contain a high concentration of methane in the voids (up to 40% CH_4), which results in explosive concentrations occuring in the discharge gallery unless adequate ventilation is installed.

If the methane concentration is above the explosive limit it remains a hazard since its concentration will pass through the explosive zone

during dilution with air. The CANMET study demonstrated that release of methane was accelerated after passing through the thermal dryer. This may be due to elevated temperature and physical degradation of the coal. The study also demonstrated that it was possible to predict the approximate methane concentrations in the coal pile from methane desorption tests.

2.1 OBJECTIVES

The previous CANMET studies were limited to two mine sites. This survey was designed to carry out investigations at all other available coal storage silos in Western Canada, and to:

- Define the hazard presented by methane accumulations in the silos studied.
- Establish the reliability of a simple methane desorption test for predicting methane emissions.
- Provide greater understanding of the factors influencing the accumulation of methane within coal silos.
- Provide operators with information from which they can take action to reduce the risk of silo explosions.
- Provide a guide to ventilation requirements in silos and in discharge galleries.

FIGURE 1-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

COMPOSITION AND EXPLOSIBILITY OF MIXTURES OF METHANE, OXYGEN AND NITROGEN
(Inflammability Triangle - After Coward 1952)

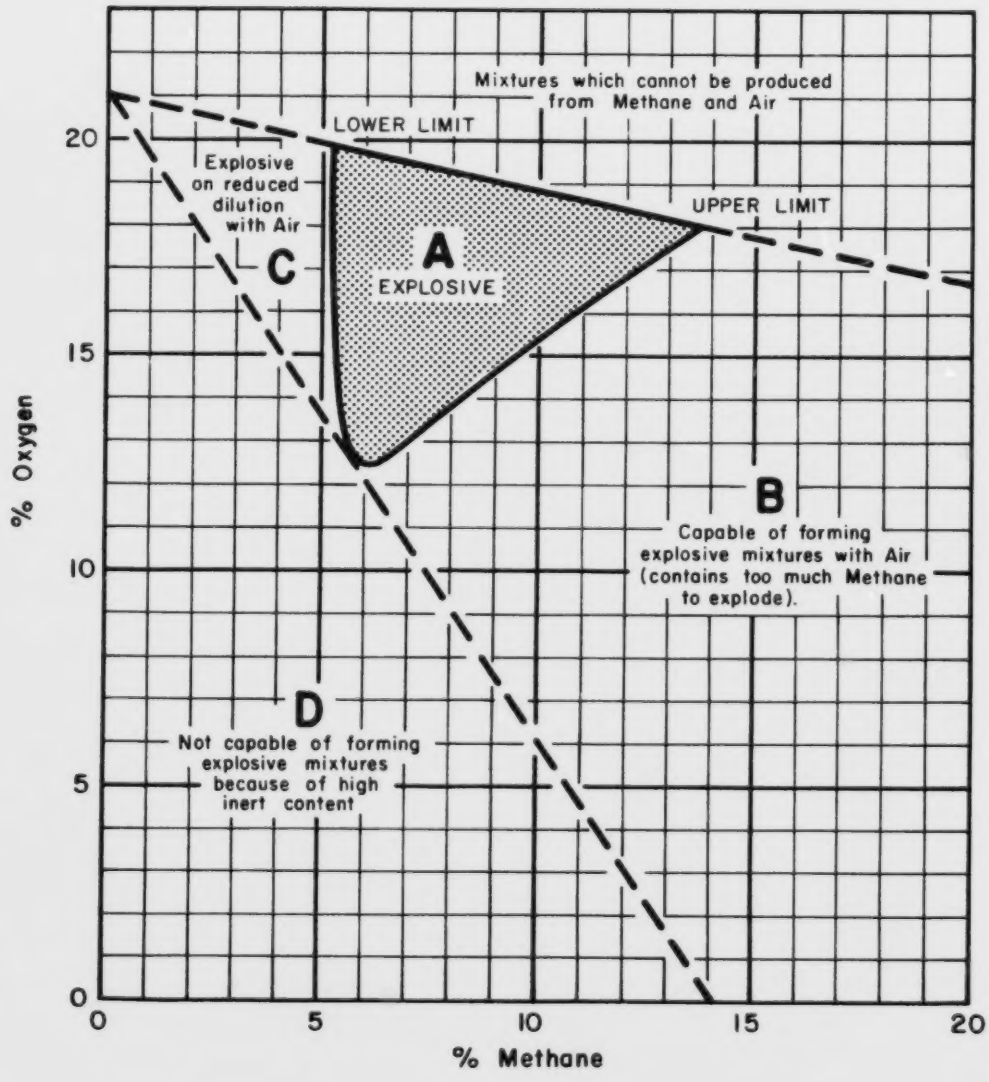
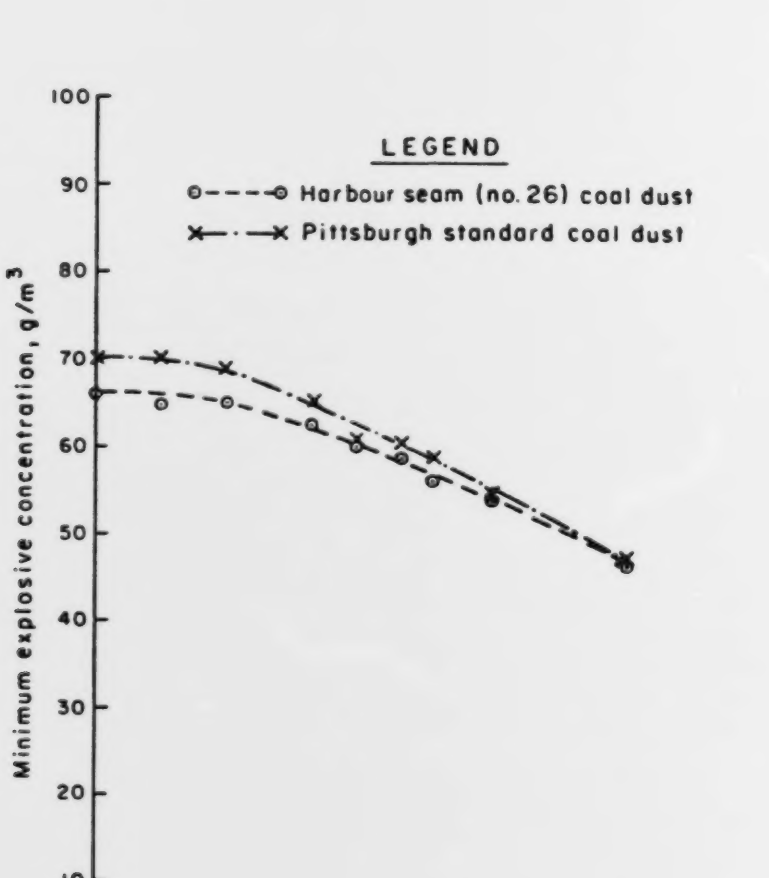


FIGURE 1-2

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

MINIMUM EXPLOSIVE CONCENTRATION OF HARBOUR SEAM (No.26) COAL DUST IN METHANE-AIR MIXTURE

(After: Feng[2])



SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 2 - METHODOLOGY AND EQUIPMENT

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(Following Text)

2-1 Methane Desorption Equipment

2-2 Silo Sampling Schematic

2-3 Above Coal Sampling - Detail

SECTION 2 - METHODOLOGY AND EQUIPMENT

2.1 INTRODUCTION

Tests were conducted at eight mines in Western Canada, all of which were in the foothills or mountain regions. Tests were not carried out at the Westar's Sparwood plant or at Line Creek Mine as these had previously been covered by CANMET investigations (5 and 6). Litigation proceedings resulting from an explosion in a silo at Fording's Elkview plant prevented AMCL from taking measurements at that mine.

Where possible and applicable, tests were conducted in the following silos at each mine:

- raw coal silo
- clean coal silo - metallurgical coal
- clean coal silo - thermal coal.

The tests were:

- methane desorption tests
- methane and oxygen levels between the silo roof and approximately 0.25 m above the coal pile surface
- methane and oxygen levels between the coal pile surface and approximately 0.25 m above
- methane and oxygen levels below the surface of the coal pile
- analyses for other gases within the pile.

These tests were conducted during loading, static and discharging conditions in the silo. The bulk density of the coal was measured or obtained from mine records. Other relevant data such as temperature, barometric pressure, seams worked, coal quality, etc. were collected or measured.

This section of the report details the methods and equipment used.

2.2 METHANE DESORPTION TESTS

Methane desorption tests were carried out on grab samples (approximately 5 increments over a 2 minute period) from the conveyor feeding the silo to be tested. The sample was taken at generally the same time that measurements of the silo gas levels commenced. The desorption apparatus is depicted in Figure 2-1.

The coal sample was placed in a weighed air-tight container which was then reweighed to determine the weight of coal sample. The cylinder outlet was attached by a tube to a graduated cylinder filled with dilute sulphuric acid. The low Ph solution was used to avoid the desorbed gas being disolved into the solution during the test and distorting the rate of desorption. The reservoir was adjusted to ensure the gases in the cylinder and sample container were at atmospheric pressure.

Desorption rates are a function of temperature, so attempts were made in some cases to keep the temperature of the sample constant. For the thermally dried coal samples which were above ambient temperatures, the containers were placed in a water bath which was maintained at a reasonably constant temperature by a topping-up procedure. Despite this precaution, condensation of water vapour may have taken place and there may have been a minor loss of volume due to cooling. In such a case the rate of desorption would be understated. The results for slowly desorbing coals would be most affected in percentage error terms.

In some cases, especially in raw coal tests, larger pieces of coal were broken to be placed in the container. Duplicate tests were performed in which no freshly broken coal was placed in the container. The results

from these tests showed that freshly fractured coal had a significantly higher desorption rate than the coal that had been broken previously.

Readings of the volume of gas desorbed were taken at regular intervals until the rate of desorption fell to less than 1 mL/kg/h.

2.3 MEASUREMENT OF GAS CONCENTRATIONS

Figure 2-2 shows a schematic of the equipment used to measure gas concentrations in the silos. Tubes were placed down access holes in the top of the silos. Gas samples were withdrawn through the tubes by a vacuum pump, and either transferred directly to gas sample bottles, or passed through a water/dust filter into a methanometer or an oxygen meter.

Thick-walled plastic tubing of 6 mm inside bore was utilized since thinner tubing squeezed shut more readily and broke earlier. Plastic tubing caused no problems when lost in the silo, which happened regularly, during silo discharge. Metal tubing, while more resistant to closure, could have caused major damage to feeders, etc. if lost in the silo coal. Ideally, a securely anchored metal conduit should be placed in the silo to allow the sampling point to be reached. This was impractical during the survey, but could be considered if a more comprehensive survey were undertaken for a single silo, or for a continuous monitoring installation.

Dust filters were placed on the end of the tubes to reduce dust intake.

For measurement of gas concentrations between the silo roof and just above the coal pile, a single tube was eventually used. Consideration was given to establishing a sampling grid over the volume to be sampled. Limited access into most silos made a grid method impractical. Sampling at various accessible points in a silo indicated

that the methane concentration did not vary measurably over the silo. The measurements showed that in a ventilated silo the general body of air from beneath the silo roof to just above the coal surface was generally homogeneous. This finding was contrary to that of USBM workers [7], who found the methane content increased slightly with depth from the roof of the silo.

The presence of pockets of air with higher concentrations of methane in areas under the silo roof cannot be completely discounted. It was physically impossible to check all areas under the silo roof.

In addition to random spot checks, the tube sampling the general body of silo air was placed 3 - 4 m below the silo roof.

To sample the gas within 0.25 m of the top of the coal pile, a second tube was used. A weight was tied to the bottom of the tube which was fitted with a dust filter and fixed directly or inverted some 0.2 m (see Figure 2-3). The tube was lowered into the silo until it reached the coal surface. Samples were taken with the tube loose with the intake presumably close to the coal surface, and also taut, when the sample intake would be 0.2 m above the coal. Care had to be taken during filling operations to avoid the sample point entering the coal pile either by incoming coal covering the intake or coal sliding over the intake. Once the sample intake was covered in coal methane levels generally increased sharply. To sample while the silo was being discharged, the tube was constantly lowered to the coal pile surface, then raised. If the tube was left on the surface, often it was found that the tube would be dragged into the discharging coal and it was extremely difficult to retrieve. Attempts were made to sample within the vortex of the coal pile during silo discharge since high methane concentrations were observed in this area on occasions.

For sampling the voids within the coal pile a single tube fitted with weight and dust filter was used. The tube was lowered to the coal surface while the silo was being filled. The coal gradually covered the end of the tube and the depth of coal above the sample point increased.

It is almost impossible to remove the tube once it is in the coal pile, so it was necessary to provide an anchor point and disconnect point ahead of the vacuum pump. On silo discharge the tube was pulled down with the coal, stretching then closing so no sample could be drawn, then eventually breaking. It was possible that with the tube closed air leakage occurred through connections to the vacuum pump and that the readings of methane concentrations were lower than the actual concentrations within the voids.

It was extremely difficult to obtain long-term measurements of methane build-up in the coal pile in those silos which were filling and discharging at the same time, e.g., raw coal silos or truck loadout silos. Either the tube would be pulled down by the discharging coal and break or the intake point would come out of the coal as the silo level dropped. Nevertheless, meaningful results were obtained, as each time the tube became uncovered could be considered a new start time and the methane build-up curve was restarted.

2.4 VACUUM PUMP

The vacuum pump used for the survey was an electrically powered portable combination pressure/vacuum type 01-094 (Fisher Scientific Limited). Specifications for the pump are:

- rate of free air displacement 113 L/min
- pressure to 103 kPa (15 psig)
- vacuum to 92 kPa (27 ins Hg)
- 1725 rpm motor 115 v - 60 Hz
- weight 15 kg.

The pump was fan cooled and fitted with lubricator, exhaust trap, pressure and vacuum gauges, bleeder, hose nipples and an intake filter with a 10 μm filter element.

2.5 ANALYTICAL EQUIPMENT

Over the course of the surveys various pieces of analytical equipment were utilized.

Gas Chromatograph - Michromonitor 500 Gas Analyzer

This was set up in a laboratory at each site as it was too sensitive to operate on top of a silo. It was used to analyze samples, taken in the air sample bottles, for methane, oxygen and other gases. The minimum detectable levels of the gases analysed are:

		ppm
CH_4	Methane	50
O_2	Oxygen	50
CO_2	Carbon Dioxide	50
CO	Carbon Monoxide	50
C_2H_6	Ethane	50
C_3H_8	Propane	5
C_4H_{10}	Butane	10
C_2H_4	Ethylene	50
C_2H_2	Acetylene	50
N_2O	Nitrous Oxide	50

Methanometers

Two types of methanometers were used, both of the infra-red type.

a. Buckman reading 0% to 10% accuracy 0.10%
0% to 100% accuracy 1%

b. Scott D.15 reading 0% to 5% accuracy 0.05%
0% to 100% accuracy 1%.

Oxygen Meters

The oxygen meter used was a Scott-Alert Model S103.

Range 0% to 25.0%
Reading to 0.1% with an accuracy of ± 3% full scale.

2.6 MEASUREMENT OF BULK DENSITY

The bulk density of coal within the silos was measured by weighing the amount of sample required to fill a box of 1 cubic foot (0.0283 m^3) capacity. The samples were loose packed and compacted. Three tests were performed and the average used.

At several mines routine bulk density measurements had been undertaken and these were used in lieu of the above tests.

The bulk density of the solid coal, or specific gravity, was obtained from the mine operators.

2.7 MEASUREMENT OF TEMPERATURE

A Mikron 44 portable infra-red thermometer was used during the initial survey to measure the surface temperature of the coal on the conveyor.

Subsequently it was considered more reliable to place a thermometer in the coal sample to obtain its temperature.

2.8 METHODOLOGY AT INDIVIDUAL MINESITES

The equipment and methodology used at individual minesites are recorded in confidential notes provided to CANMET under separate cover.

FIGURE 2-1
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

METHANE DESORPTION EQUIPMENT
(After Kolada [5])

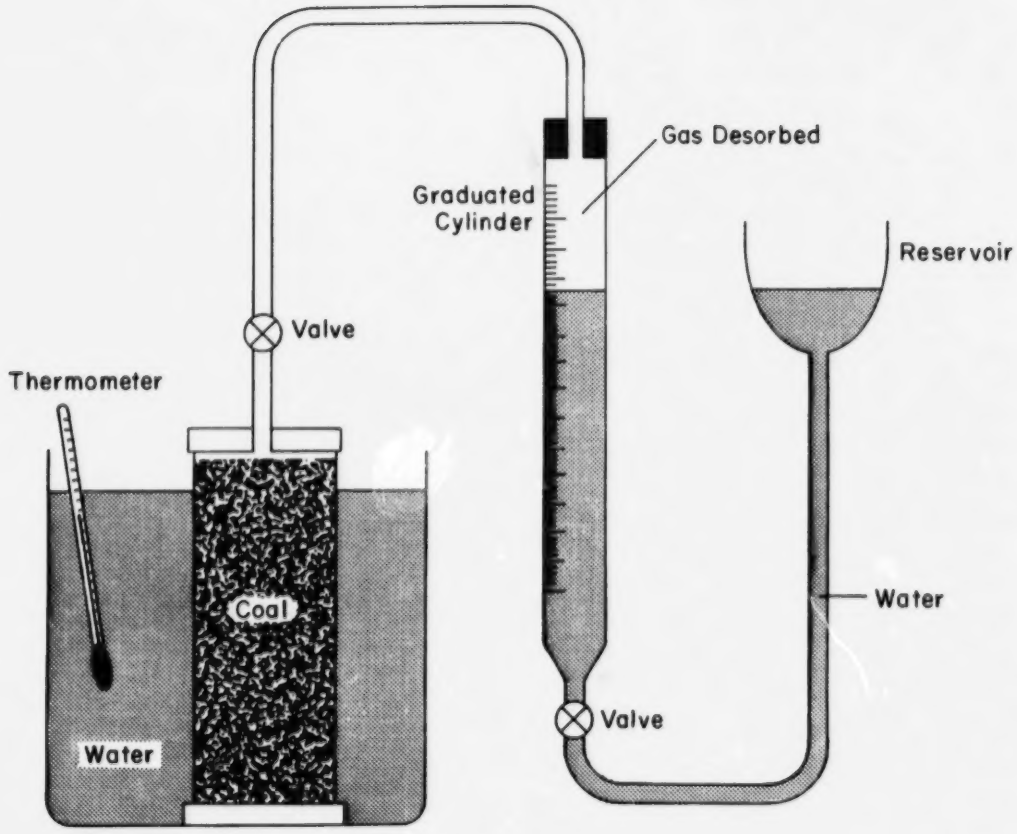

FIGURE 2-2

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SILO SAMPLING SCHEMATIC

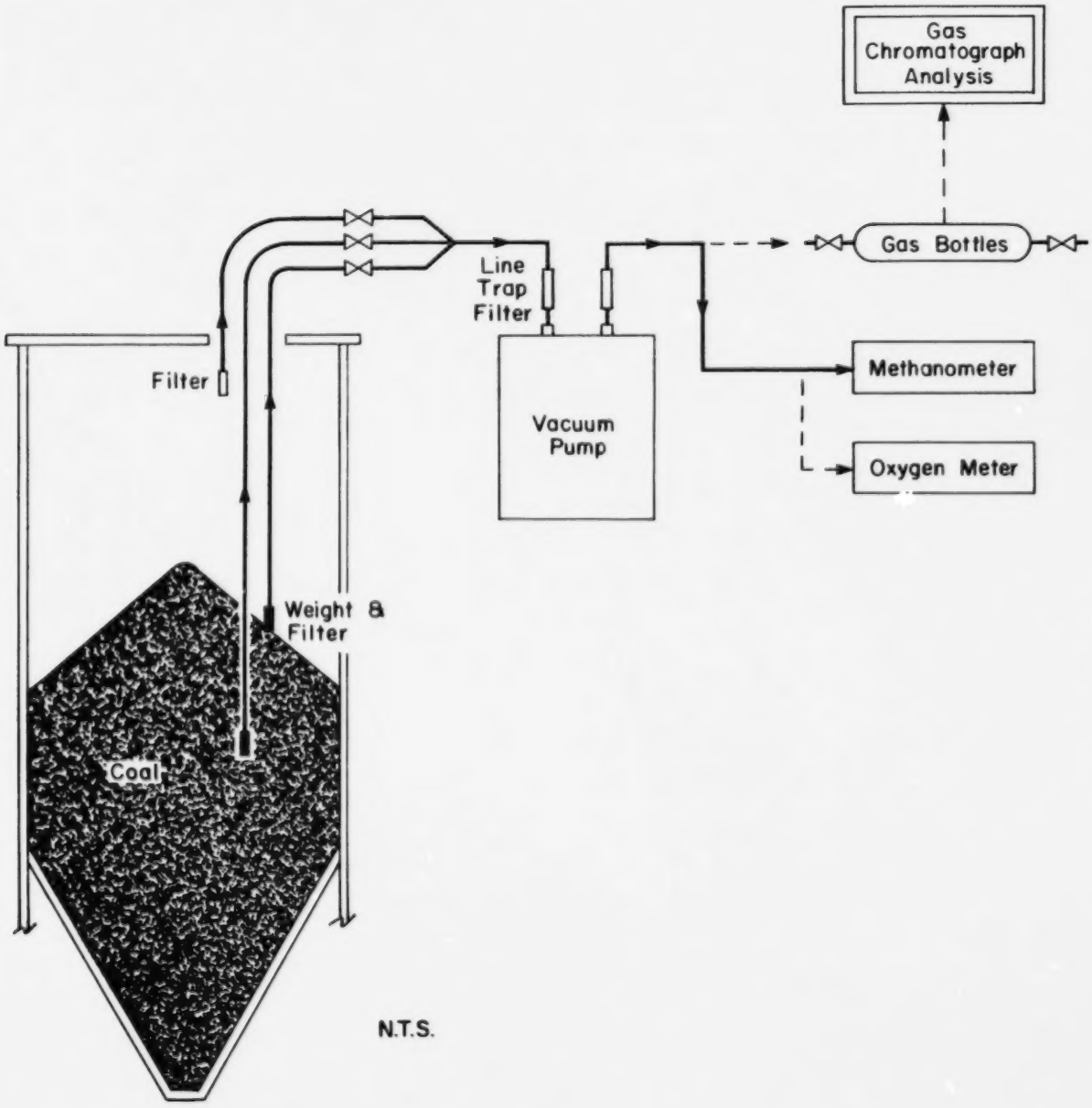

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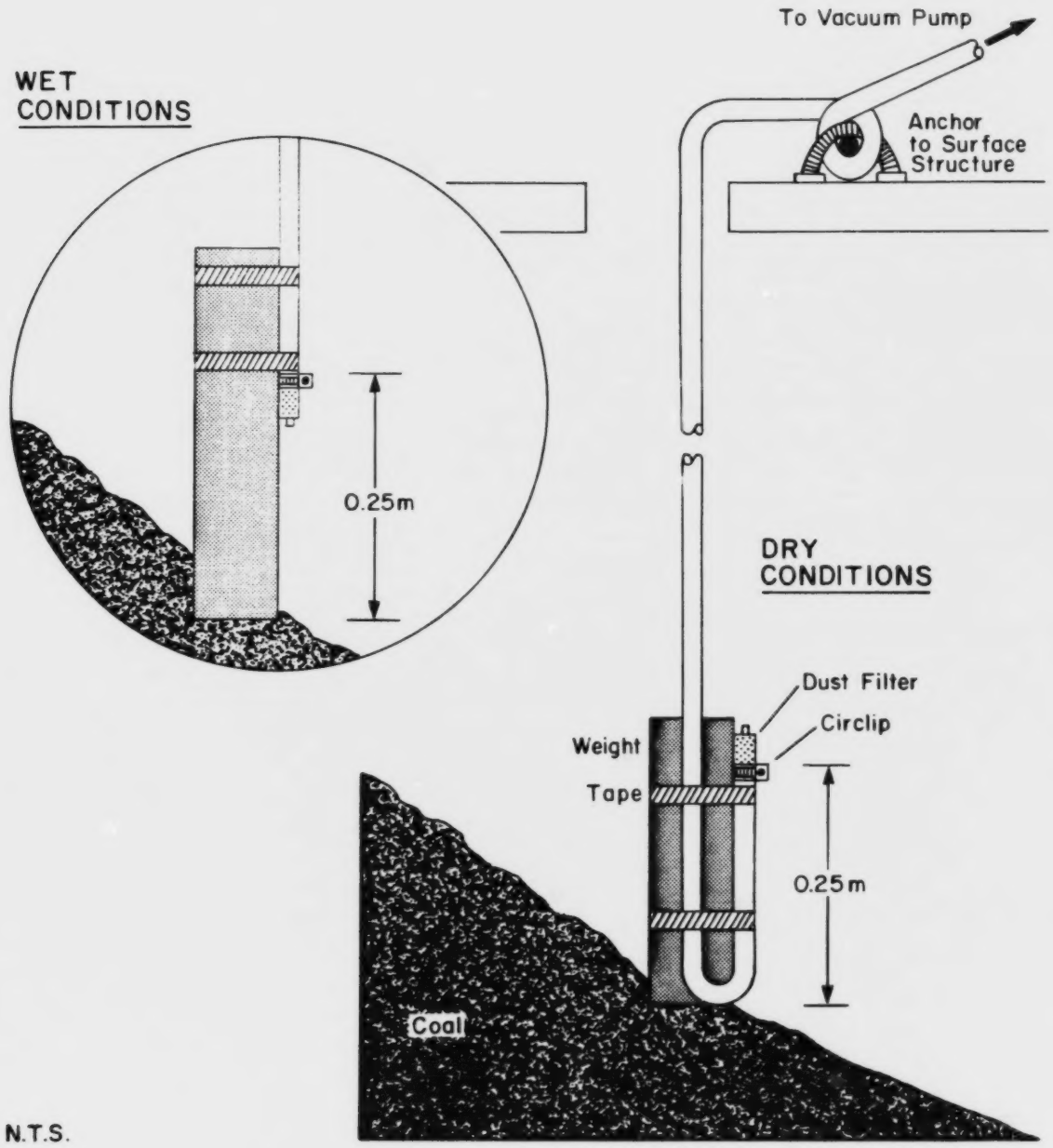
FIGURE 2-3

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

ABOVE COAL SAMPLING - DETAIL



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SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 3 - RESULTS

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.....Cont'd

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 3 - RESULTS

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3-12 Results of Survey - Mine H - Clean

3-13 Results of Survey - Mine I - Clean Metallurgical

SECTION 3 - RESULTS

3.1 INTRODUCTION

The results of the measurements taken are presented in this section. A summary of relevant minesite data is also provided. (see Tables 3-1 and 3-2).

3.2 DESCRIPTION OF SILOS AND VENTILATION METHODS

The various types of silo investigated can be classified in the following three groups, as illustrated in Figure 3-1. It was observed during the survey that while the general type of design fitted into the above catagories, there were differing modifications to the design at each mine. In certain cases the upper vents were in the walls of the silos and in others the vents were on the top of the silos. Similarly, in certain cases there were mesh covered explosion hatches which acted as ventilation hatches.

It was observed that the differing methods of ventilating the feed conveyor gallery and the head house had a convection effect on the silo air.

Silo Type A

This type of silo was essentially totally enclosed, relying on the ventilation of the head house and openings via the head house to ventilate the silo. There was generally positive ventilation in the conveyor gallery and into head house with exhaust to atmosphere from the silo and head house by a scrubber. During the measurement of the

methane content of silo air it was noted that convection currents were in existance, identified by minor fluctuations in readings when they were taken on a continuous basis. For record purposes the upper limits of these fluctuations were booked at the time of reading.

Eight of the silos at the mines visited were in this category.

Silo Type B

This type in general had positive ventilation in the feed conveyor gallery and either an internal or external scrubber/fan exhausting to atmosphere. This type also had open vents or ports to atmosphere at the top, or in the silo near the top, of the silo. In some cases the scrubber/fan served two silos and in other cases a separate exhausting system was installed for each silo. Of the mines visited 11 silos were of this type.

Silo Type C

In this type of silo there was a significant area of the silo open to atmosphere. It was observed that the natural convection currents formed by loading and emptying, plus the thermal currents generated by the variations in temperature of the coal and atmosphere, and varied changes in barometric pressure maintained a low methane content in the silo air. The transfer point itself was in a covered house and ventilated by the conveyor gallery. Three silos were in this category.

Discharge

All the mines visited dispatched their product by rail. Bunkerage at the rail loadout was in silos mounted either directly over the rail cars, or near the loadout. Draw off from the bottom of the silos was generally at a rate of 4000 to 5000 t/h, permitting flood loading of the trains.

The rate of discharge was always in excess of the silo filling rate and in all cases there was provision for fresh air to enter the silo from the top during the discharge from the silo.

Typical types of discharge layout are shown in Figure 3-1.

Silo Discharge Type X

The silo discharges into a weigh hopper sized according to the car or truck container for dispatch.

Silo Discharge Type Y

The silo discharges directly into a truck or rail car.

Silo Discharge Type Z

The silo discharges onto a transfer conveyor which is usually in a confined space. The belt conveyor then transports the coal to a truck or loadout facility.

In discharge Type Z the point of discharge and the conveyor gallery may require ventilation to dilute the methane in the silo to below the explosive level.

3.3 MINING METHODS

All the mines visited were surface operations where the overburden was removed by either shovel or dragline, or a combination of both (see Table 3-2). In all cases the top-soil was first removed and stored for reclamation and then the overburden was drilled and blasted if required and excavated by either dragline or shovel. The material was either direct cast to spoil or transported by truck for spoil disposal and reclamation.

The coal was then removed by shovel or front-end-loader and transported by truck or belt conveyor to a raw coal stockpile or silo or direct to the coal preparation plant. At all the mines the coal was sized by crushing to 50 mm or less before processing. The depth of cover at the mines varied from 20 m to 100 m.

3.4 COAL QUALITY

The type of coal processing and the proximate analysis of the products are also shown on Table 3-2. The coals varied in rank from low volatile to high volatile bituminous and were dried to a moisture content of 10% or less. The process varied at each mine in either the treatment of large coal, fines or disposal of waste, but all but one included a method of thermally drying the product as shown in Table 3-2. At the time of the survey no excessively hot coal product was observed.

3.5 METHANE DESORPTION

The results of the methane desorption tests are given in Tables A-1 to A-47 in Appendix A.

The actual volume of gas desorbed is reported. The cumulative volume desorbed per kg was calculated knowing the sample weight. Likewise the rate of desorption was calculated by taking the volume change over the time period between measurements. The desorption rate so calculated was considered to occur at the midpoint in time between the two readings.

The methane concentration in the voids of the coal pile was computed as follows:

Volume Fraction of Methane = desorbed volume per tonne/(desorbed volume per tonne + void volume per tonne)

Void Volume Per Tonne (L) = Fraction of Voids/Bulk density x 1000

Where bulk density = tonnes/m^3

Fraction of Voids = 1 - (bulk density of coal/solid density of coal)

In this case the desorbed volume per tonne is inputted in litres for any given time (t).

3.6 GAS ANALYSES

The results of the measurements taken of the atmosphere in the silos are illustrated in graphical form for each mine in Figures 3-2 to 3-13. Details of the gas sample measurements taken in the silos are recorded in Tables B-1 to B-14 (Appendix B). These tables record:

- silo air - samples 3 m to 4 m below silo roof
- within 0.25 m - just above surface of coal pile
- in coal - sample tube buried in coal pile.

The detailed analyses of the gases including methane are also presented.

The desorption rate curves for each silo/mine are shown as Figures E-1 to E-18 in Appendix E.

3.7 COMPARISON OF METHANE MEASURED AND PREDICTED VALUES

The measured methane concentrations in the voids of the coal pile are plotted against those predicted from the methane desorption tests as Figures C-1 to C-19 (Appendix C). In cases where the sample tube released from the coal during measurements, the elapsed time was reverted to zero.

3.8 METHANE/OXYGEN RELATIONSHIP

For each mine, the methane/oxygen relationship was plotted against inflammability triangle. These plots, shown in Appendix D (Figures D-1 to D-14), indicate whether the mixture in the coal became explosive and whether it would become explosive if dilution with air. Further discussion on these graphs is presented in Section 4 of the report.

3.9 OTHER GASES

During the measurement of methane content within the coal in the silos, samples of the atmosphere in the voids were taken by passing the gas through double valved canisters. One end was sealed and when pressurized the second valve was closed, ensuring that the sample was under positive pressure. The sample was then passed through the Gas Chromatograph in laboratory conditions. Gases found in measurable quantities were:

	Percent by Volume			
Oxygen (O_2)	2.0	-	19.30	
Methane (CH_4)	0.01	-	42.75	
Carbon Dioxide ($C0_2$)	0.03	-	3.13	
Carbon Monoxide (CO)	0	-	0.03	(trace)
Ethylene (C_2H_4)	0	-	0.03	(trace)
Ethane (C_2H_6)	0	-	0.05	
Propane (C_3H_8)	0	-	0.02	(trace)
Nitrous Oxide (N_2O)	0	-	0.10	
Acetylene (C_2H_2)	0	-	0.02	(trace)
Butane (C_4H_{10})	0	-	0.002	(trace)

Over 100 samples were taken and analysed through the Gas Chromatograph. In general the oxygen deficiency was replaced by methane and to a minor extent by carbon dioxide. The chromatograph analyses verify the survey readings taken by other instruments.

At four mines the presence of **carbon monoxide** could be detected and at two of those mines **nitrous oxide** could also be detected. These results suggest that periodic analyses of the atmosphere at such places as the loadout should be made.

The detailed analyses of the gases other than methane are also presented in Appendix B.

3.10 EFFECT OF BREAKAGE OF COAL SAMPLE

Care was taken to quarter samples to select the specimen for desorption. As the specimen measured was less than 1.5 kg there was concern over the effect of the size consist of the material tested. To assess the probable effect (if any) of recent breakage, two specimens were taken of the same sample at one mine. In the case of one of the specimens the upper size material was broken with a hammer just before inserting in the desorption cannister. The results showed that over a 9-hour period the unbroken coal generated 80 mL/kg while the freshly broken coal generated 160 mL/kg over the same time period. As attrition and degredation of size can take place during transportation there is a likelyhood that methane could be released at such places as transfer points where attrition can occur.

3.11 HIGHLIGHTS OF THE SURVEY

At Mine A, the methane desorption measured on samples in an intermediate truck loadout were considerably higher than those at the terminal rail loadout. This was also reflected in the methane concentrations measured in the voids in the respective silos. Concentrations in the silo air and near the surface of the coal never exceeded 0.15%.

At Mine B the coal was being shipped as a screened raw product. There was no silo as such, but a train loadout bin. Methane concentration

within the bin remained at less than 1%. The desorption rate of the coal prior to screening was higher than that after screening. Trace levels only were measured in the atmosphere within the bin.

Mine C had an exceptionally high desorption rate which was reflected in even higher methane concentrations in the voids in the silo. A repeat visit to this mine confirmed the order of magnitude. It was also found that the build-up time to reach near maximum concentration was less than 20 minutes. In this particular case, due to the rate of coal feed, the time equates to a coal thickness of 8 inches or 0.2 m at the surface of the pile below which the concentration of methane within the voids is fairly constant. Turbulance during discharge generated readings up to 2.3% near the surface of the coal, with the silo air in general remaining around the 1% level. In static conditions the silo air remained below the 0.6% level.

Mine D was a classic case where the predicted concentration was very close to the actual measured. Readings were up to 20% in the coal and 1.1% to 1.4% above the coal with general silo air readings of 0.5% to 1.8%. The mine is in the process of installing additional ventilation to reduce these levels.

Mine E coal was an exception to the general experience. The rate of desorption was comparatively slow but sufficient to determine a prediction into the explosive range within less than one hour. The anomaly was that there was no measurable methane within the voids, although as in all cases, the equipment was checked for leaks. Readings above the surface of the coal varied from 0 to 0.2% methane while those in the general silo air varied between 0 and 0.4%.

At Mine F the predicted level of methane concentration in the voids was similar to that measured in the silo on a second survey. On the first survey comparative low readings were observed except when the sampling tube was drawn into the vortex of the discharge when an

exceptionally high reading was observed. In each case the survey equipment was checked for leaks and verification samples taken. In a test for build-up time of methane concentration within the voids without product discharge from the silo, static concentrations were developed in 90 minutes.

Mine G has no silo as such and was not producing fresh product at the time of the survey. No measurements were taken.

At Mine H there were both raw and clean coal silos. The predicted levels of methane were higher than measured in the raw coal silos. In the clean coal silos the two curves were identical, the prediction being the same as the actual. In the case of the raw coal silos the methane concentration varied from a trace to 0.1% and just above the coal surface was a trace to 1.1%. In the case of the clean coal silo the silo air readings varied from 0.1% to 0.3% with 0.05% to 0.15% above the coal surface.

At Mine I there was slow desorption at the product samples which generated a low prediction. The actual methane concentration within the voids was marginally higher than predicted and reached within the explosive range for methane but with a significantly reduced level of oxygen rendering the mixture non-explosive. Readings of methane concentration above the surface of the coal varied from 0 to 5.0% with the silo air remaining in the 0 to 0.13% range.

In all but one case the methane concentration was actually above the 5% minimum explosive limit for a methane air mixture. However, this explosive limit is lower if coal dust is present. There is, therefore, an interface where the explosive limit can be exposed when the product is exposed to air.

TABLE 3-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SUMMARY OF INFORMATION ON SILOS

Mine	Product	Number of Silos	Type of Silo	Type of Discharge	Capacity t	Ventilation m^3/s (cfm)	Remarks
A	Raw	1	A	Z	4,000	Scrubber 3.162 (6,700)	
	Clean	1	B	2	5,000	2.313 (4,900)	
	Met.Clean Med.Vol.Bit.	2	A	Y	each 11,500	3.115 (6,600)	
B	Thermal Med.Vol.Bit.	-	-	-	100	-	Rail Loadout Bin
C	Met Coal Clean Med.Vol.Bit.	1	C	Z	12,000	open top	
D	Thermal Coal High Vol.Bit.	2	A	Z	each 8,000	-	
E	Raw	2	A	Z	each 1,800	-	
	Clean Met.Med.Vol.Bit.	2	B	Y	each 13,500	2.218 (4,700) to 2.974 (6,300)	
F	Met.Med.Vol.Bit	2	B	Z	each 12,500	each 1.416 (3,000)	
G	Thermal High Vol. Bit.	-	-	-	-	-	Rail loadout storage No measurable desorption
H	Met./Therm. Raw	3	B	Z	8,000	4.413 (9,350)	
	Clean	3	B	Z	12,500	4.413 (9,350)	
I	Met.Low Vol.Bit. Raw Coal	1	A	Z	2,000	-	
	Clean Coal	2	C	Z	each 7,500	-	

TABLE 3-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

MINING METHODS AND QUALITY OF PRODUCT

Mine	Mining Method	Number of Seams	Depth of Cover (m)	Type of Preparation*	Moisture	Proximate Analysis of Product			FSI
						Ash	Volatile Matter	Fixed Carbon	
A	Truck and Shovel	2	30	HMC; WOWC; FF; RVF; FB.	5.5	8.3	26.2	60.0	6.5
B	Truck and Shovel	1	35	J; RVF.	8.0	16.0	22-25	51-54	-
C	Truck and Shovel	1	approx.90	HMC;WOWC;FF;SBC; RVF; FB;FRD; BC.	10.0	9.8	21.8	58.4	6.5
D	Dragline/Truck and Shovel	4	20	HMV; HMC; WOWC; SBC; FB; TWBP.	8.2	9.8	21.7	60.3	-
E	Truck and Shovel	3	50	HMC; FF; RVF; FB;	4.2	7.1	25.9	62.8	7.5
F	Truck and Shovel	1	40	HMV; HMC; WOWC; FF; RVF; FB; FRD; BC.	9.8	10.0	20.0	60.2	6.5
G	Dragline/Truck and Shovel	2	20-33	J; FRD; SBC; RKD.	8.0	13.0	36.0	43.0	-
H	Truck and Shovel	5	up to 75	HMV; HMC; FF; RVF; FB; SBC.	8.0	9.5	22.5	60.0	6.5
I	Truck and Shovel	a	100	HMC; FF; RVF; FB; SBC; HoloFlyte Dryer	7.5	6.0	17.5 - 20	66.5 - 69	7 - 9

HMV Heavy Medium Vessels
HMC Heavy Medium cyclones
J Jig
WOWC Water Only Washing Cyclones
FF Froth Flotation
FCD Fine Coal Dewatering
BC FCD Bowl Centrifuge
RVF FCD Rotary Vacuum Disk Filter
SBC Screen Bowl Centrifuge
TD Thermal Dryer
FB Fluid Bed Dryer
FRD Fine Rejects Dewatering
TWBP Twin Wire Belt Presses
RKD Rotary Kiln Dryer

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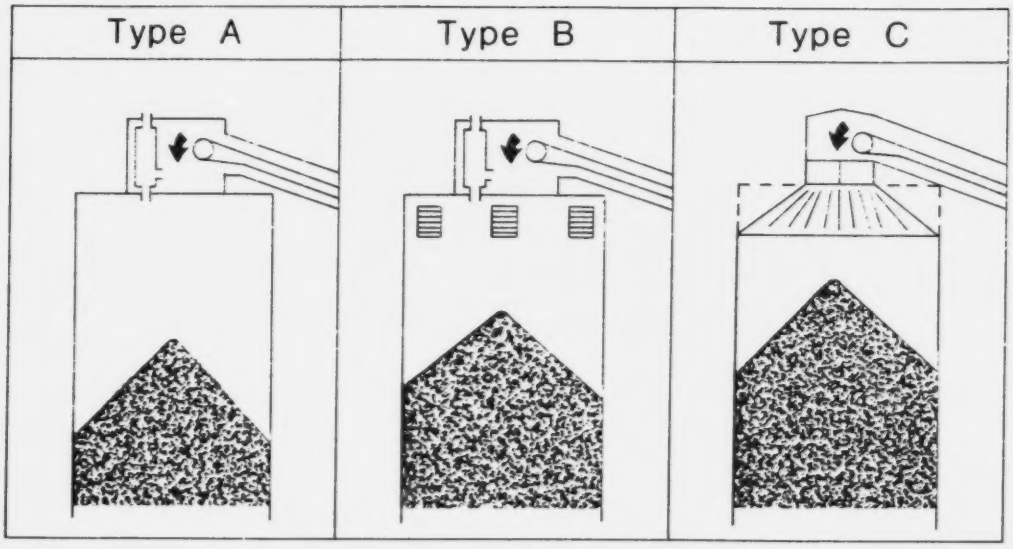
FIGURE 3-1
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

SILO AND DISCHARGE TYPES

FEED VENTILATION



DISCHARGE

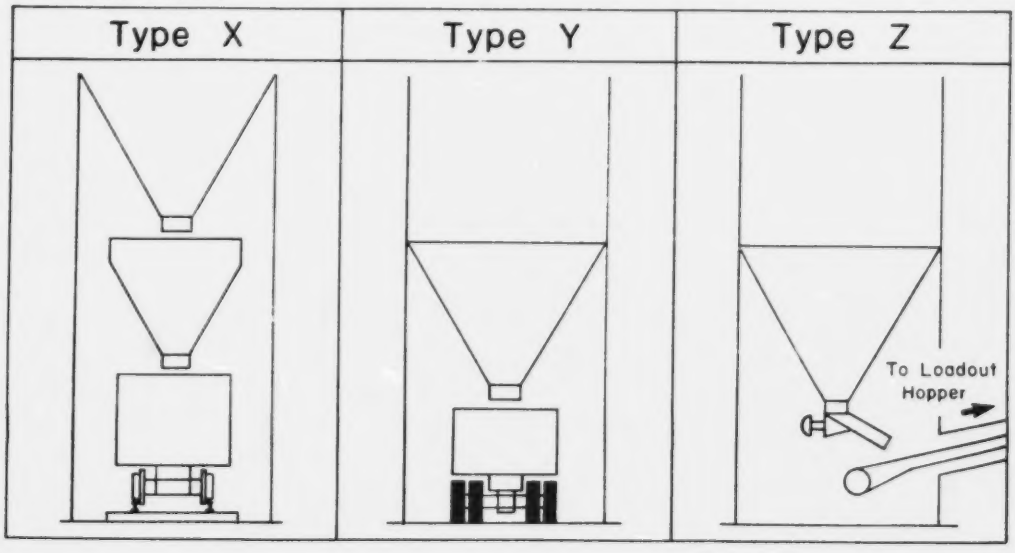


FIGURE 3-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE A - RAW METALLURGICAL

Mine: A
Sampling Data: August 15, 1985
Coal Temperature: 28°C
Coal Product: Raw Metallurgical

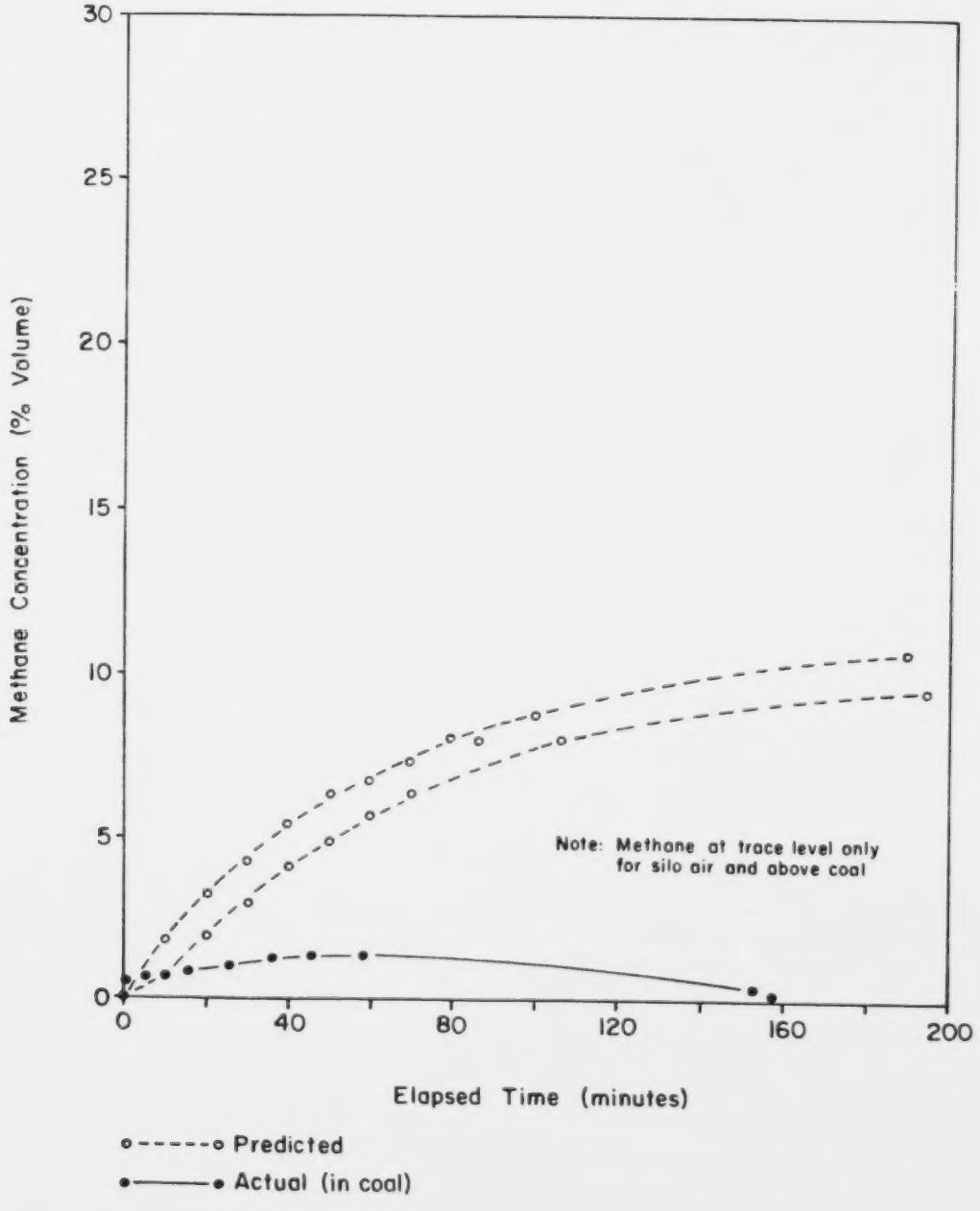


FIGURE 3-3
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE A - CLEAN METALLURGICAL (Truck Loadout)

Mine: A
Sampling Data: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical (Truck Loadout)

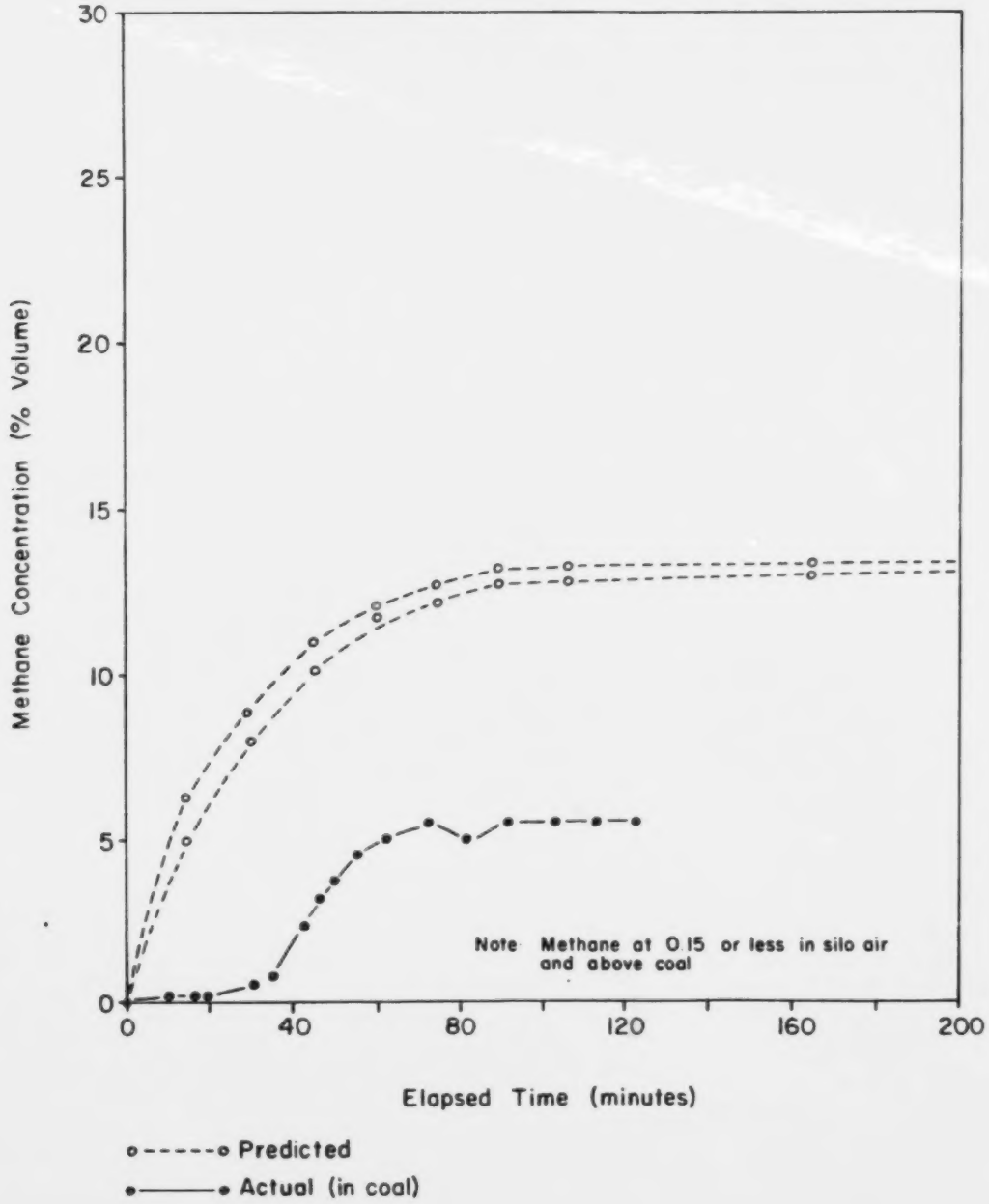


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FIGURE 3-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE A - CLEAN METALLURGICAL (Rail Loadout)

Mine: A
Sampling Data: August 16, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical (Rail Loadout)

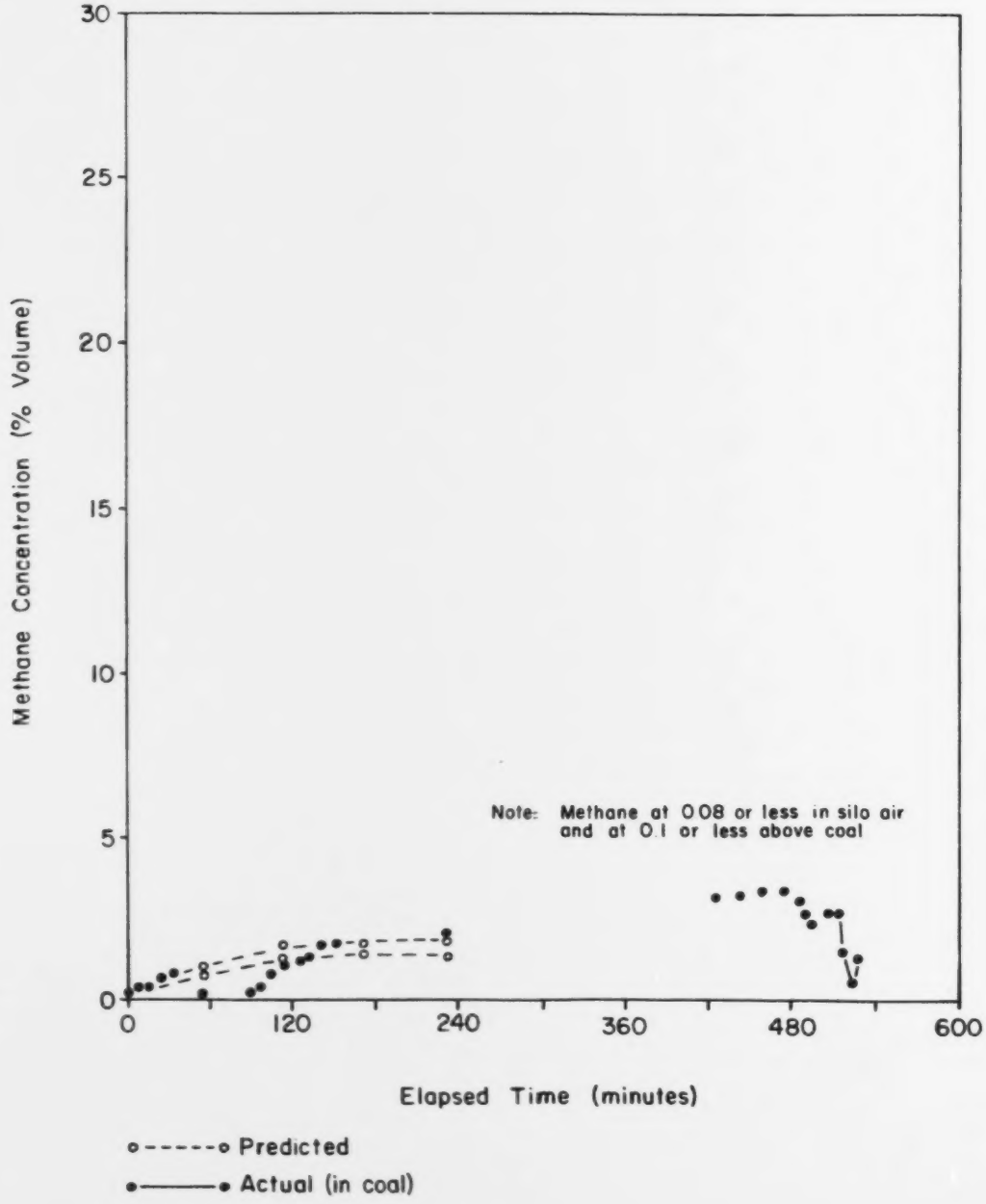

FIGURE 3-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE C - CLEAN METALLURGICAL

Mine: C
Sampling Data: June 12/13, 1985
Coal Temperature: 35°C
Coal Product: Clean Metallurgical

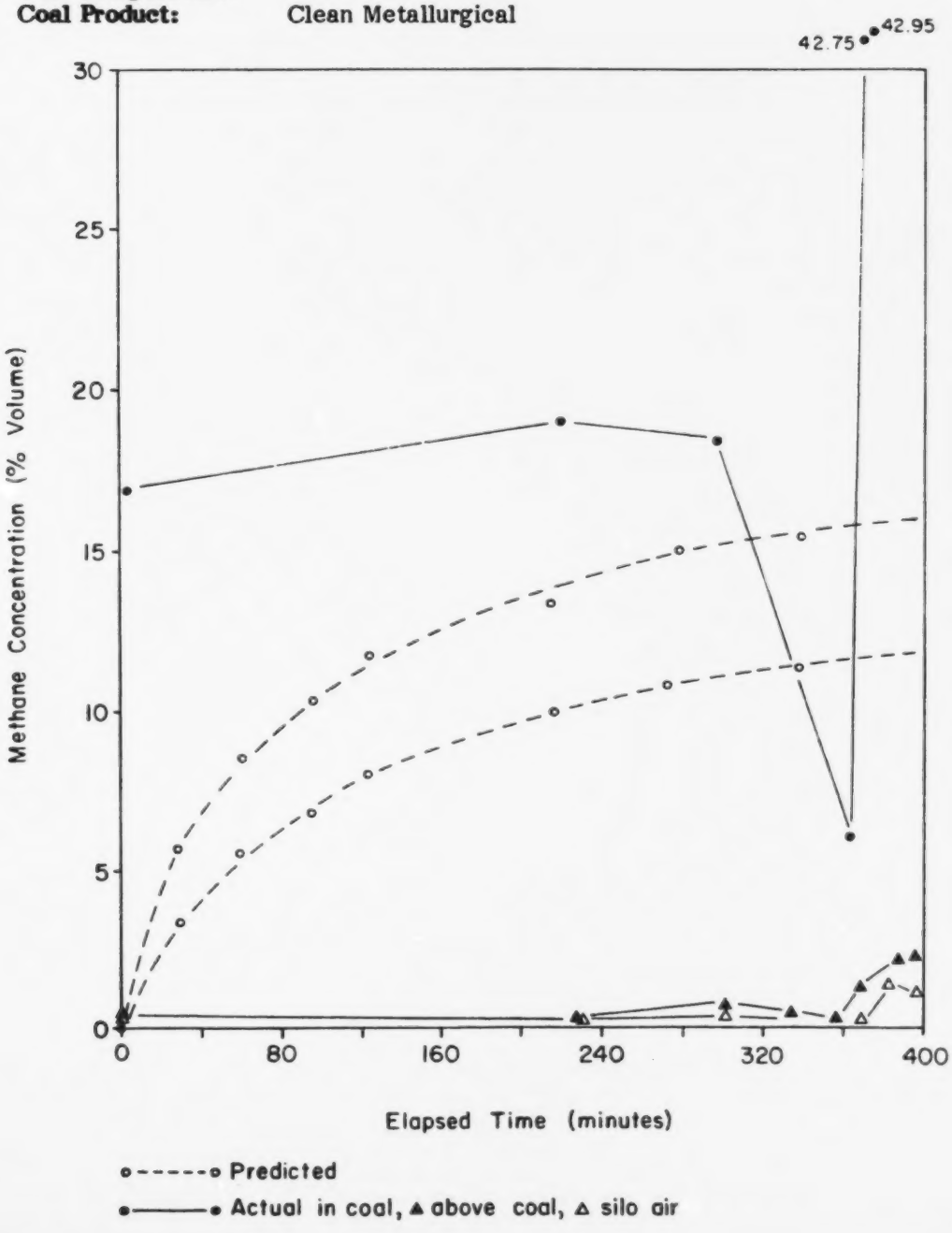

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FIGURE 3-6
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE C - CLEAN METALLURGICAL

Mine: C
Sampling Data: September 10, 1985
Coal Temperature: 38°C
Coal Product: Clean Metallurgical

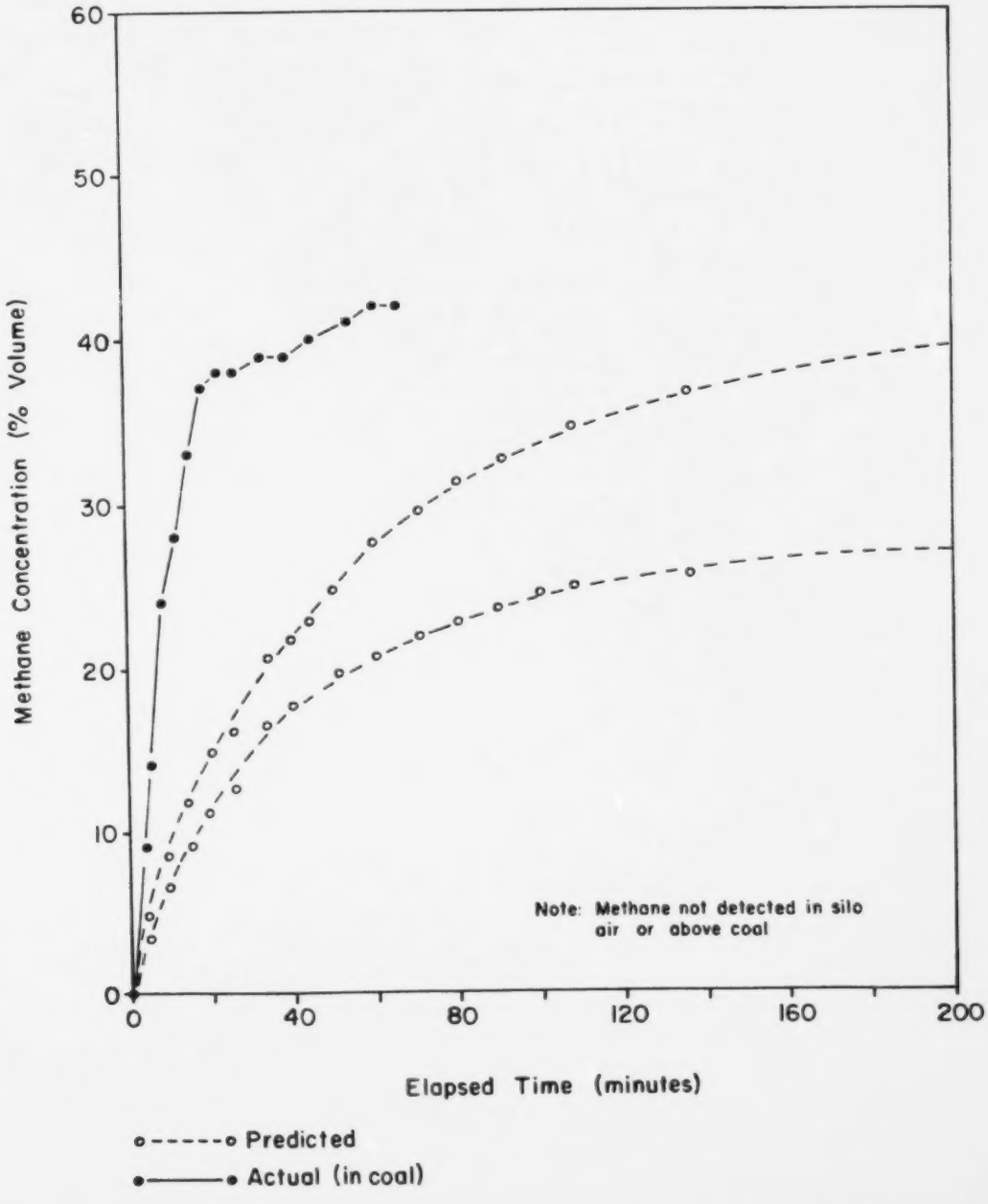

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FIGURE 3-7

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE D - CLEAN THERMAL

Mine: D
Sampling Data: May 22/23, 1985
Coal Temperature: 40°C
Coal Product: Clean Thermal

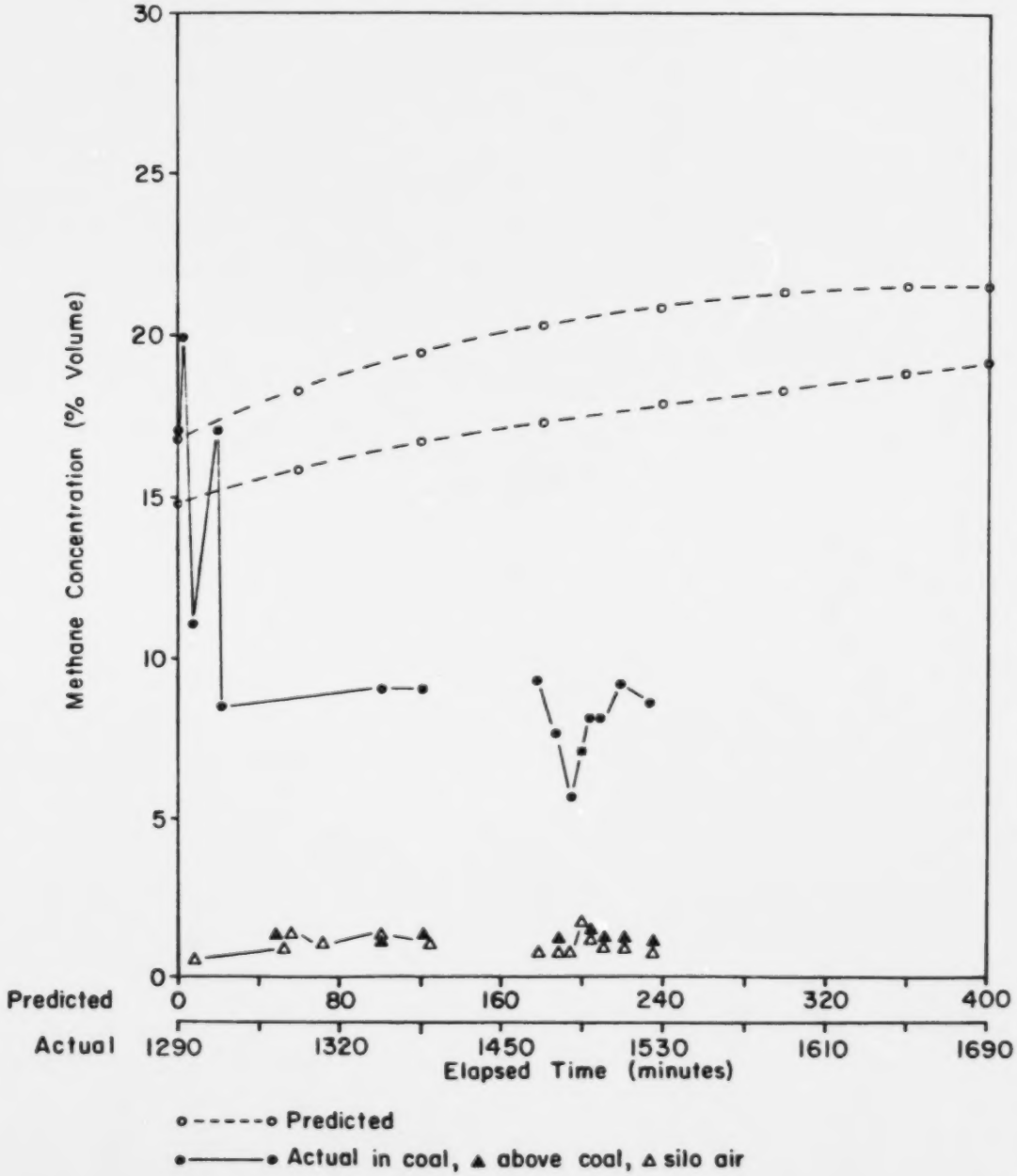

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FIGURE 3-8

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE E - CLEAN METALLURGICAL

Mine: E
Sampling Data: July 18, 1985
Coal Temperature: 45°C
Coal Product: Clean Metallurgical

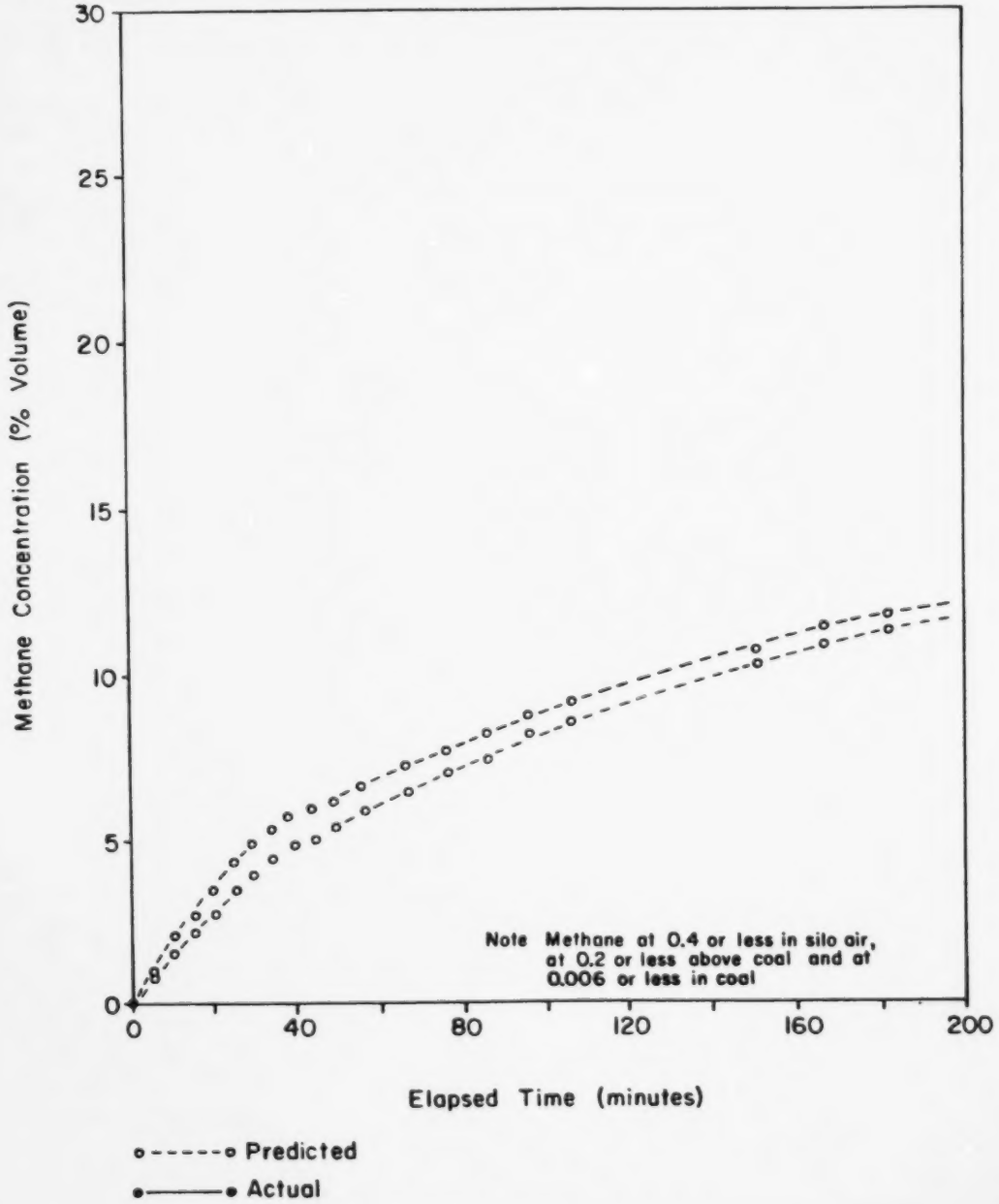

FIGURE 3-9
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

RESULTS OF SURVEY - MINE F - CLEAN METALLURGICAL

Mine: F
Sampling Data: June 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

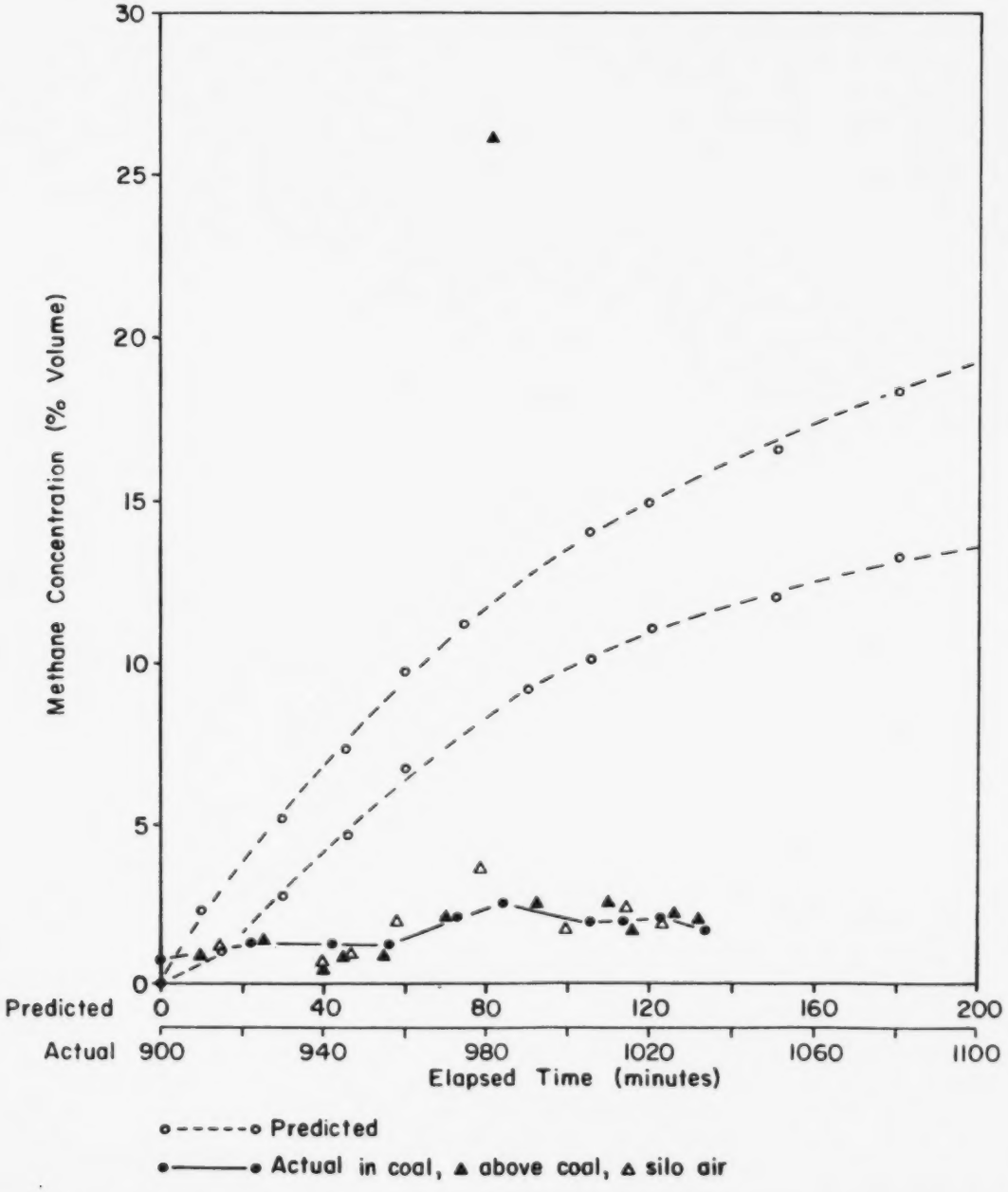

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FIGURE 3-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE F - CLEAN METALLURGICAL

Mine: F
Sampling Data: September 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

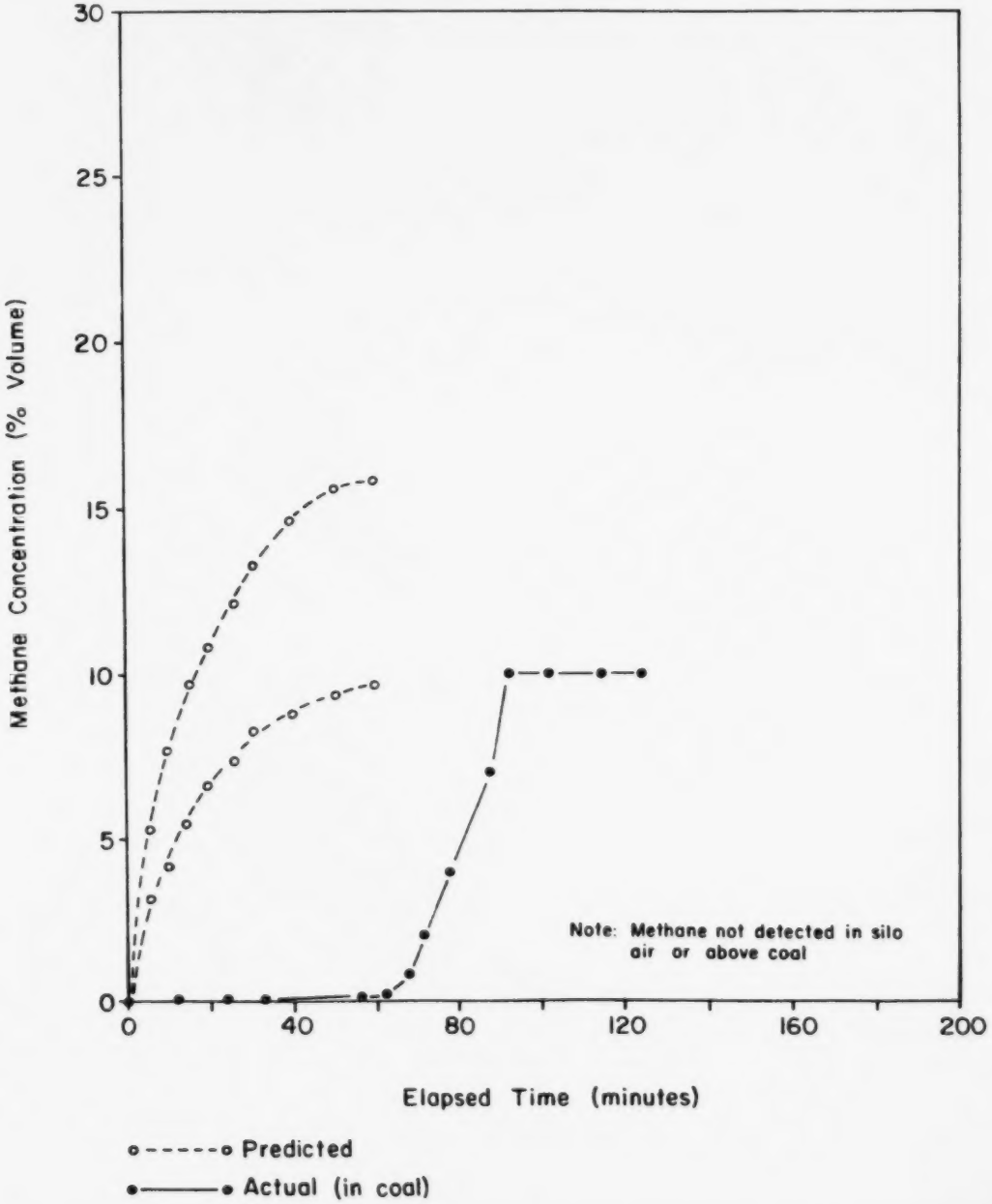

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FIGURE 3-11
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE H - RAW METALLURGICAL

Mine: H
Sampling Data: August 13, 1985
Coal Temperature: 20°C
Coal Product: Raw Metallurgical

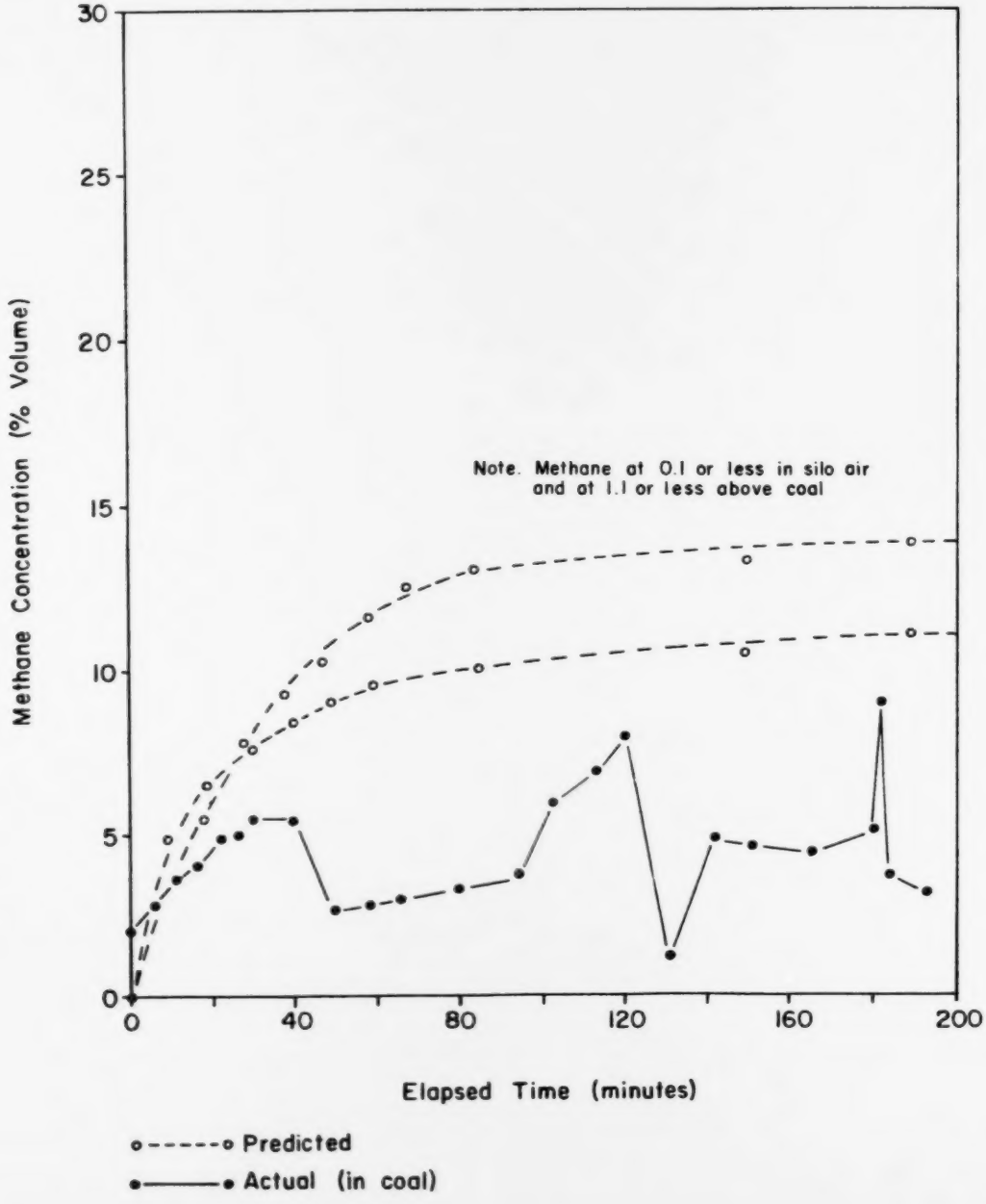

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FIGURE 3-12

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE H - CLEAN

Mine: H
Sampling Data: August 14/18, 1985
Coal Temperature: 32°/37°C
Coal Product: Clean

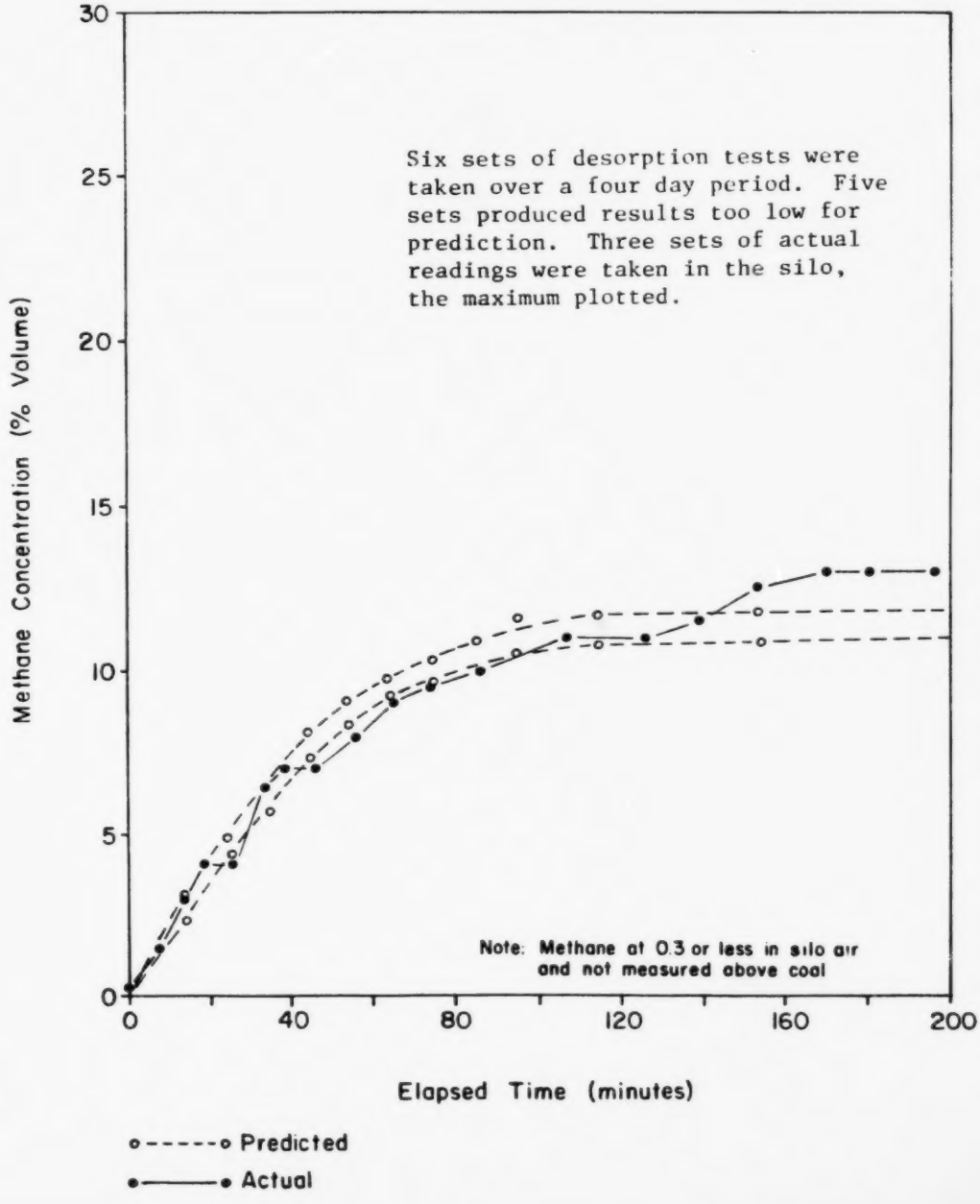
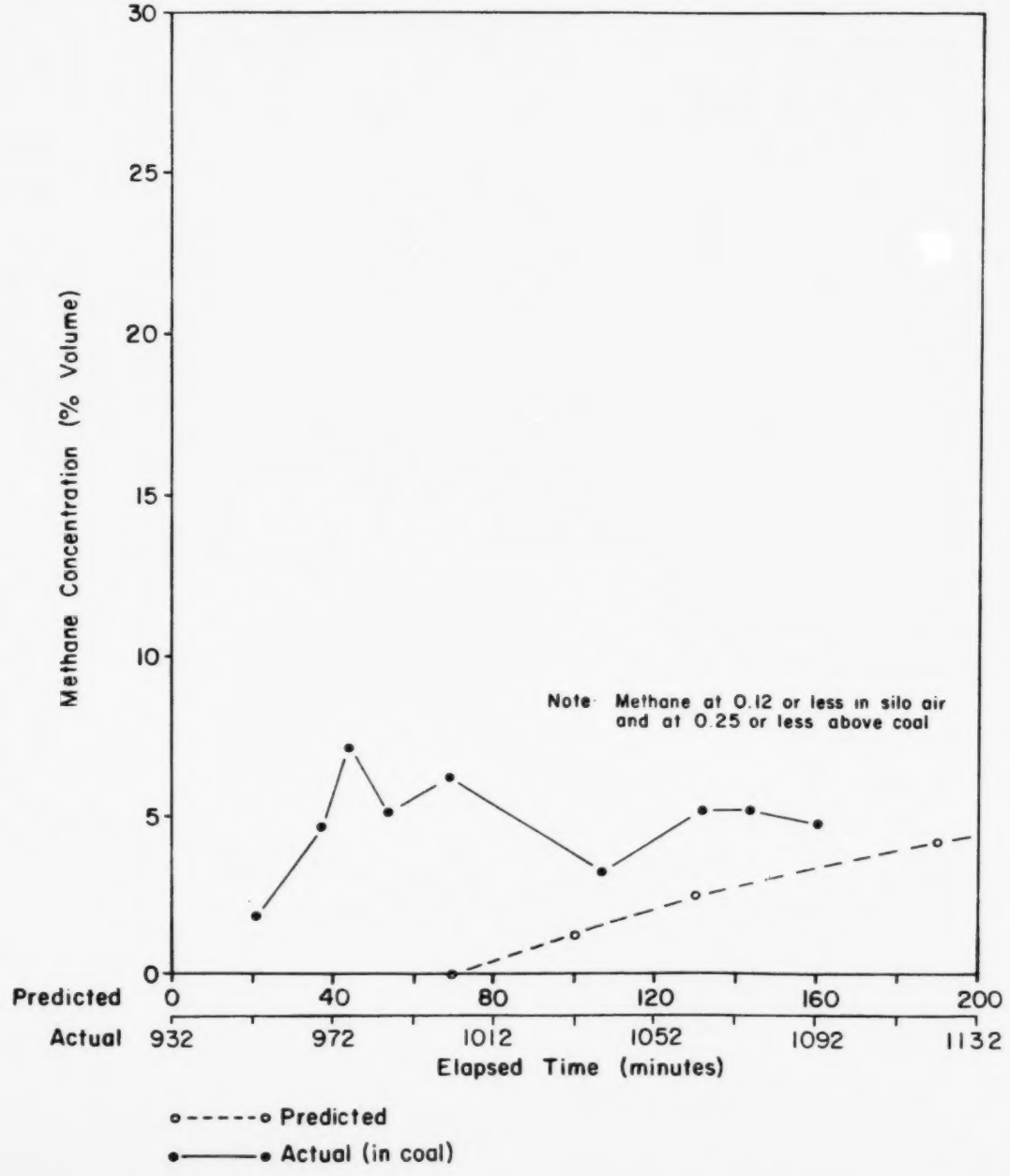


FIGURE 3-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RESULTS OF SURVEY - MINE I - CLEAN METALLURGICAL

Mine: I
Sampling Data: July 25/26, 1985
Coal Temperature: 27°C
Coal Product: Clean Metallurgical



SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 4 - DISCUSSION

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4-3 Actual and Predicted Accumulation of Methane - All Mines

4-4 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine A - Clean Metallurgical (Truck Loadout)

4-5 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine C - Clean Metallurgical

4-6 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine D - Clean Thermal

4-7 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine E - Clean Metallurgical

4-8 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine F - Clean Metallurgical

4-9 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine H - Clean

4-10 Predicted and Actual Accumulation of Methane (Zero Time Base) Mine I - Clean Metallurgical

SECTION 4 - DISCUSSION

This section presents a discussion on the results of the survey and suggests possible causes of anomalies observed.

For discussion purposes two composite graphs of information from the mines visited, one showing an interpretation of the observed methane readings (Figure 4-1) and the other showing an interpretation of the predicted methane content within the voids in the silos (Figure 4-2). On both graphs the information has been transposed to a zero time base for a possible comparison. Both the accumulation and the prediction concentrations of methane for all mines are shown on Figure 4-3.

In addition the predicted and actual methane content is shown on separate graphs for individual mines (Figures 4-4 to 4-10). It is noted that in the seven cases plotted where a prediction could be made, three cases had a higher than predicted level while four had less than predicted. The scatter indicates that spot samples will give an indication only. In all but one case the voids contained a methane content within or above the explosive limits.

It appears that as the product is placed in the silo there is a reduction in the rate of desorption when the material becomes covered. **In the tests conducted in the immediate sub-surface it appeared that the near to maximum concentration was found within 0.1 m to 0.2 m thickness of coal at the surface of the pile.** (In the opinion of AMCL this phenomenon explains the fact that silo air is not saturated with methane when there is no movement of the product). In a similar context the exposed faces of the product cease to desorb methane at a measurable rate after a certain length of time. This may be less than one hour to over 24 hours. The majority of the coals tested stabilized after 3 to 4 hours. Again due to the wide scatter repeat measurements should be taken over periods of time before such measurements are used for ventilation design purposes.

When repeat samples were taken even over a short time period, differing results were observed. **These results emphasize the need for continuous monitoring for methane at any points in the handling system where there could be a source of ignition.** As noted in the text for the effect of coal breakage this itself is a concern as to accurate assessment of the rate methane release. When the tests for desorption are being made for calculating the ventilation requirement, it would be advisable to include a breakage test and so have an indication of the effect of breakage.

FIGURE 4-1
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

ACTUAL ACCUMULATION OF METHANE - ALL MINES

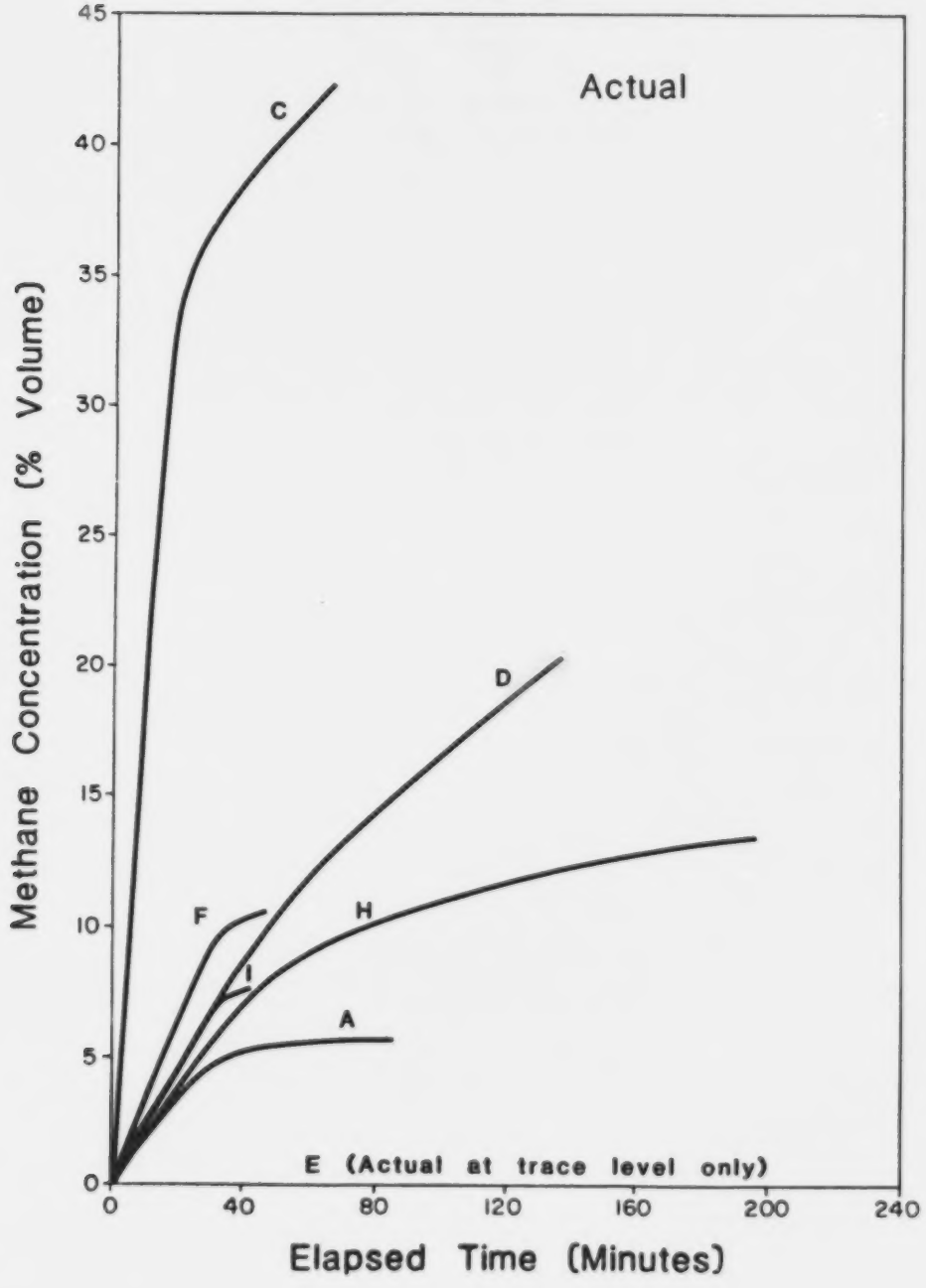

FIGURE 4-2
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

PREDICTED ACCUMULATION OF METHANE - ALL MINES

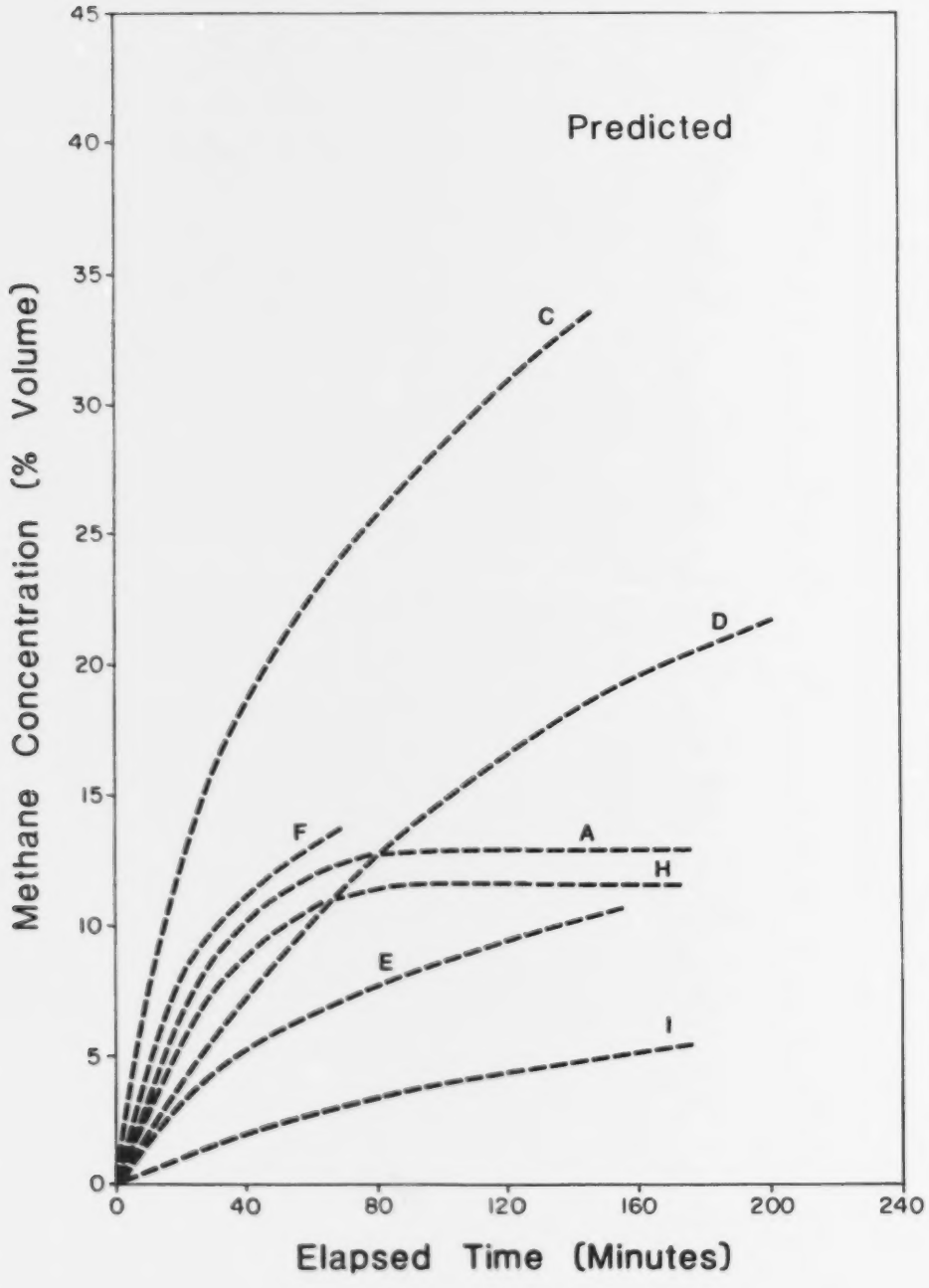

FIGURE 4-3
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

ACTUAL AND PREDICTED ACCUMULATION OF METHANE - ALL MINES

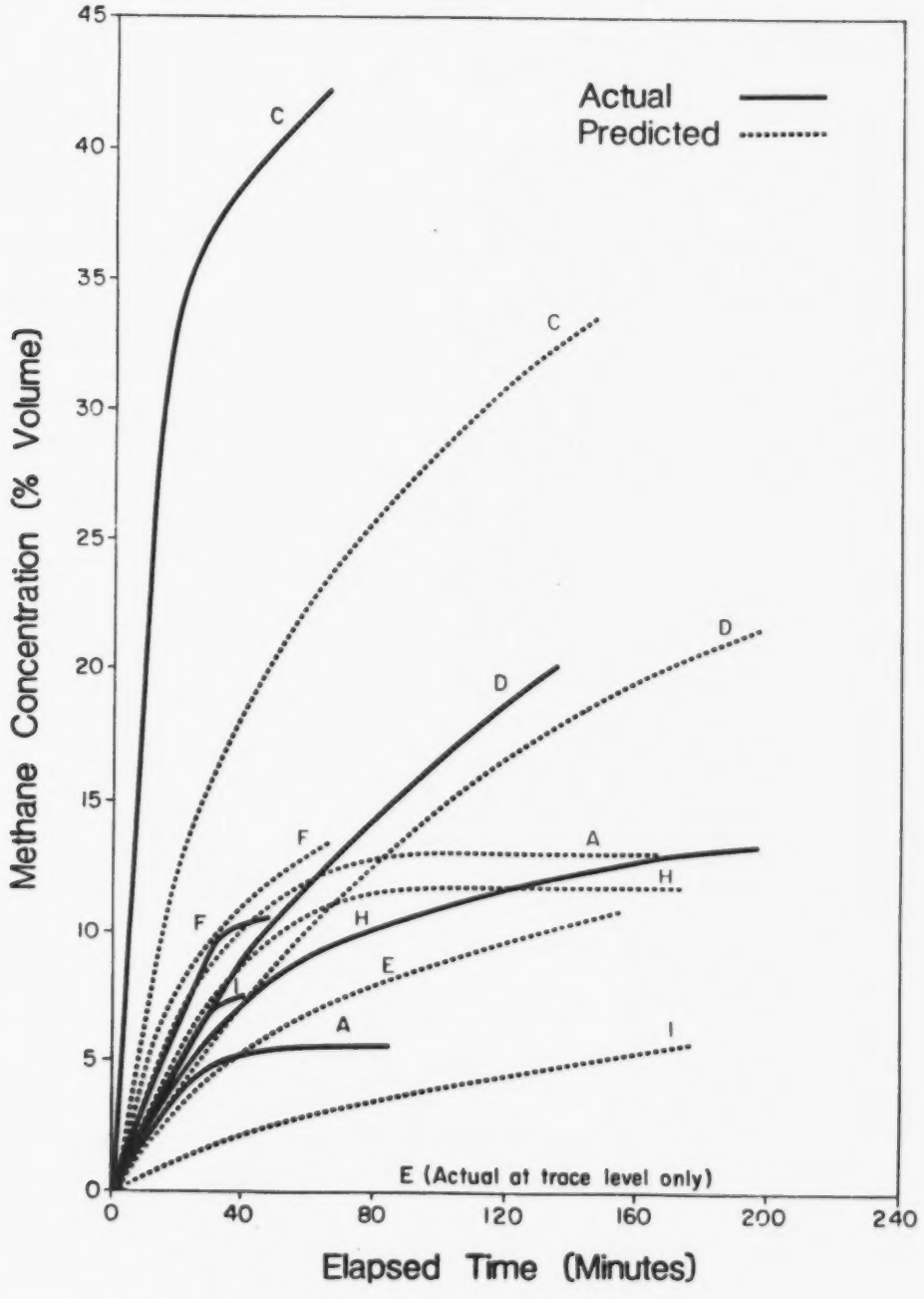

FIGURE 4-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE (Zero Time Base) - Mine A - Clean Metallurgical (Truck Loadout)

Mine: A
Sampling Data: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical (Truck Loadout)

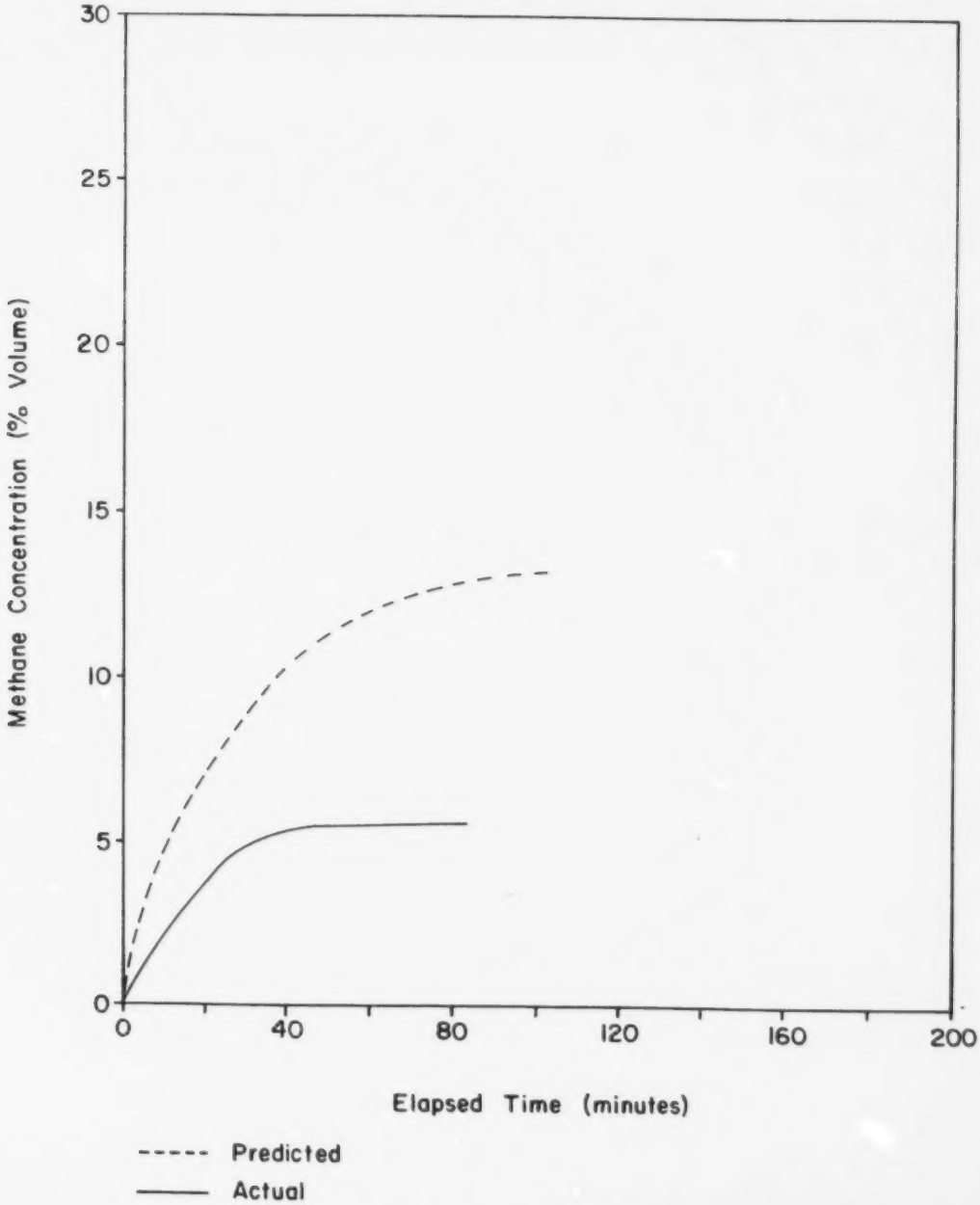

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FIGURE 4-5

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE

(Zero Time Base) - Mine C - Clean Metallurgical

Mine: C
Sampling Data: September 10, 1985
Coal Temperature: 38°C
Coal Product: Clean Metallurgical

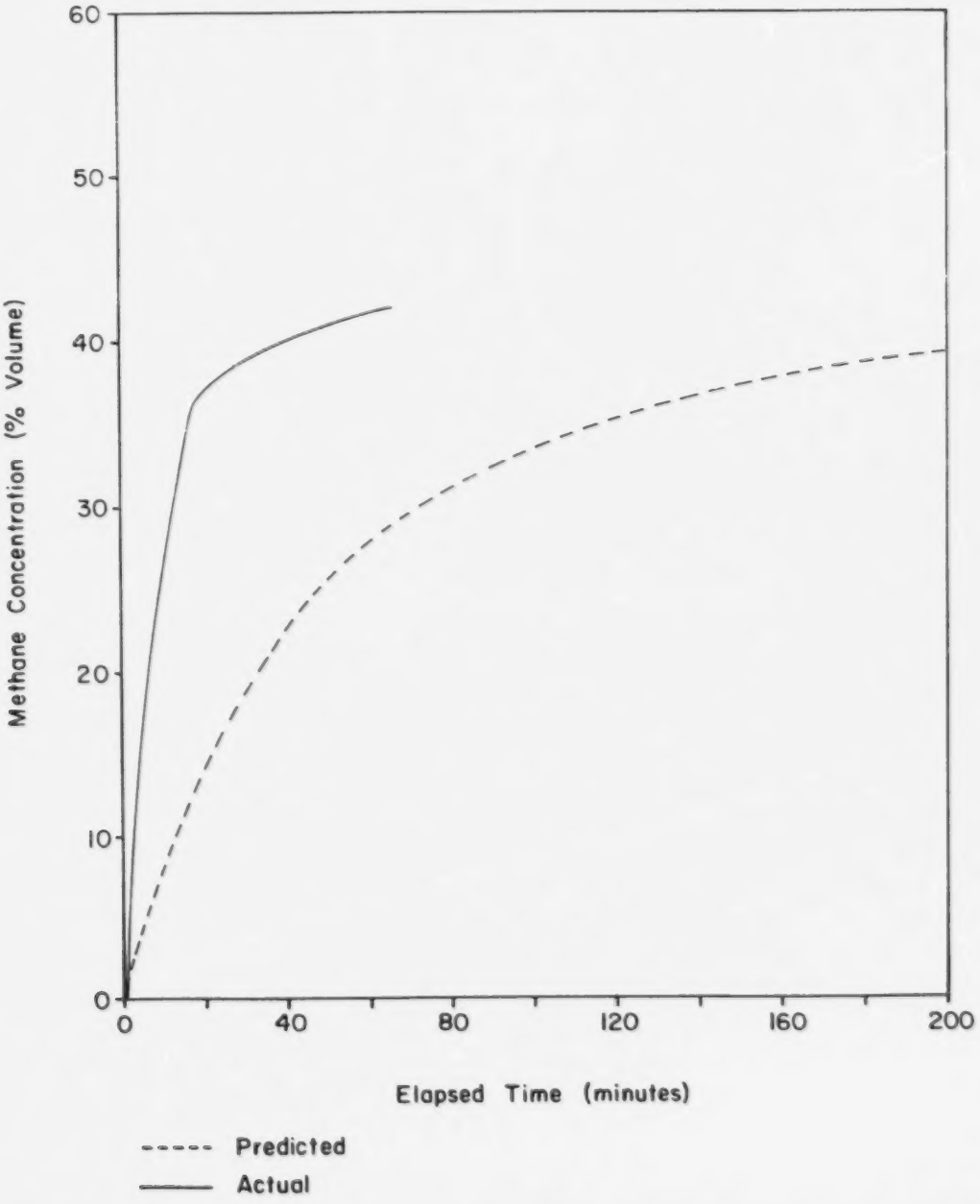

FIGURE 4-6

SURVEY OF METHANE ACCUMULATION

WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE

(Zero Time Base) - Mine D - Clean Thermal

Mine: D
Sampling Data: May 22/23, 1985
Coal Temperature: 40°C
Coal Product: Clean Thermal

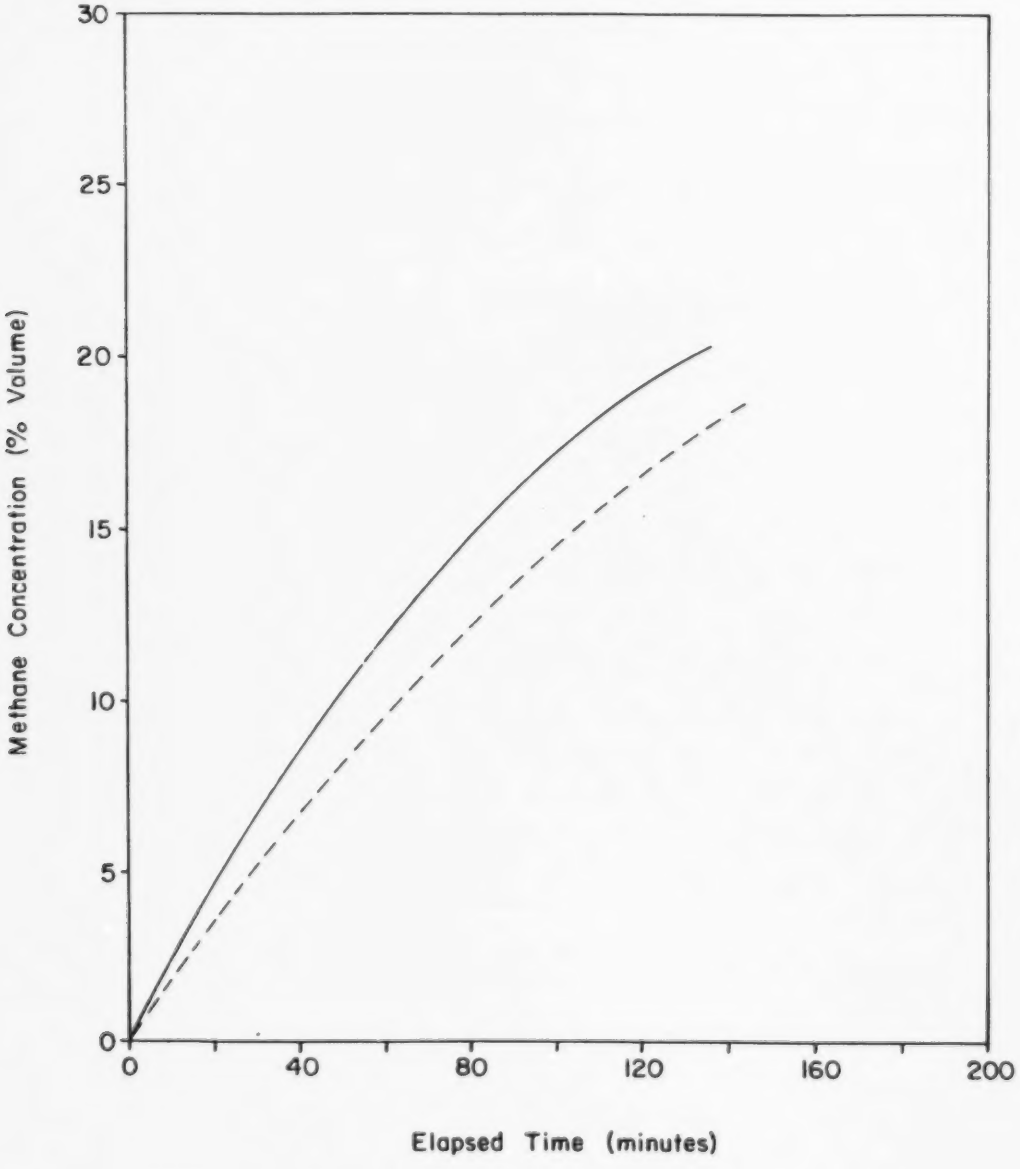

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FIGURE 4-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE (Zero Time Base) - Mine E - Clean Metallurgical

Mine: E
Sampling Data: July 18, 1985
Coal Temperature: 45°C
Coal Product: Clean Metallurgical

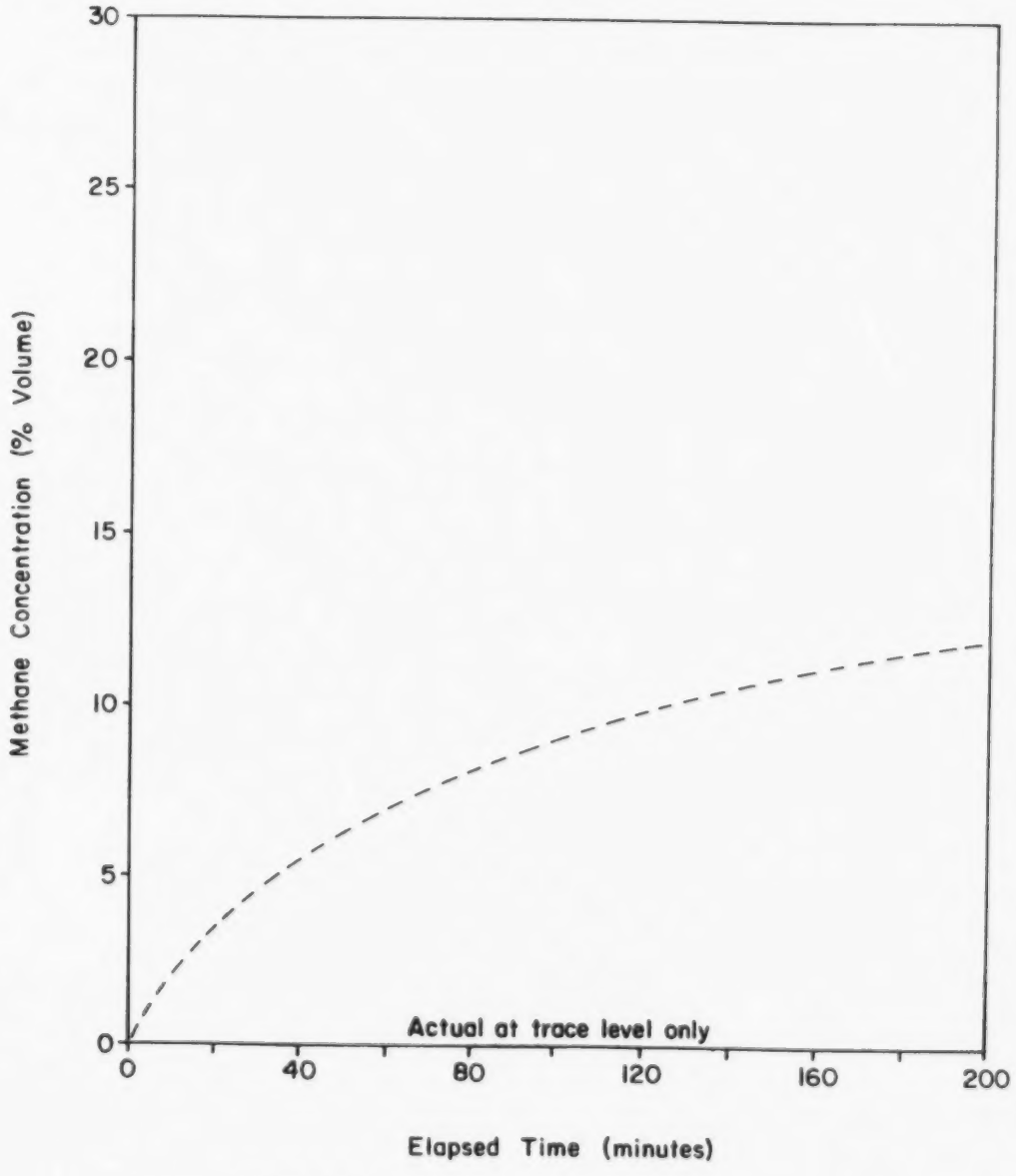

FIGURE 4-8
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE (Zero Time Base) - Mine F - Clean Metallurgical

Mine: F
Sampling Data: September 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

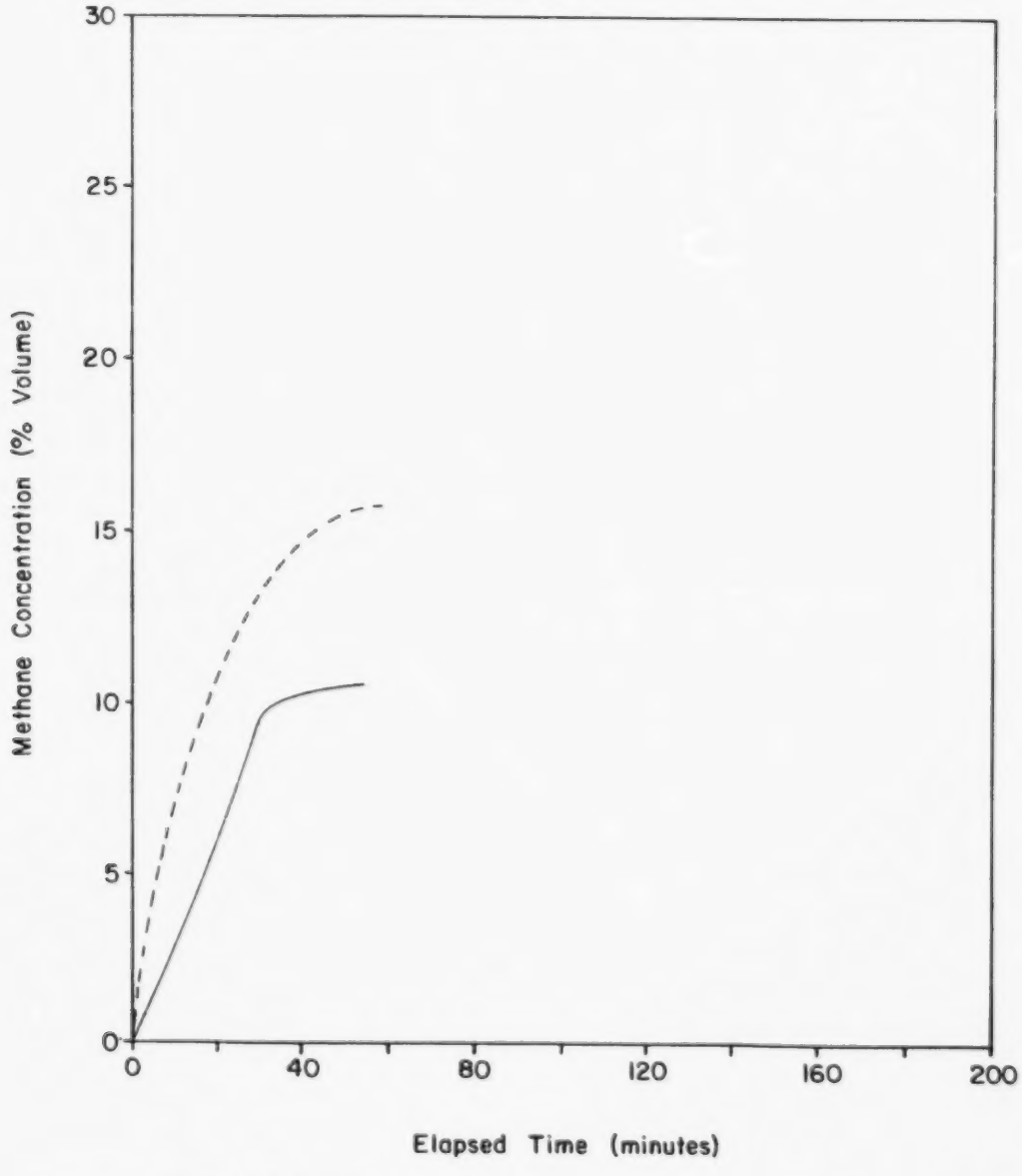

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FIGURE 4-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE (Zero Time Base) - Mine H - Clean

Mine: H
Sampling Data: August 14/18, 1985
Coal Temperature: 32°/37°C
Coal Product: Clean

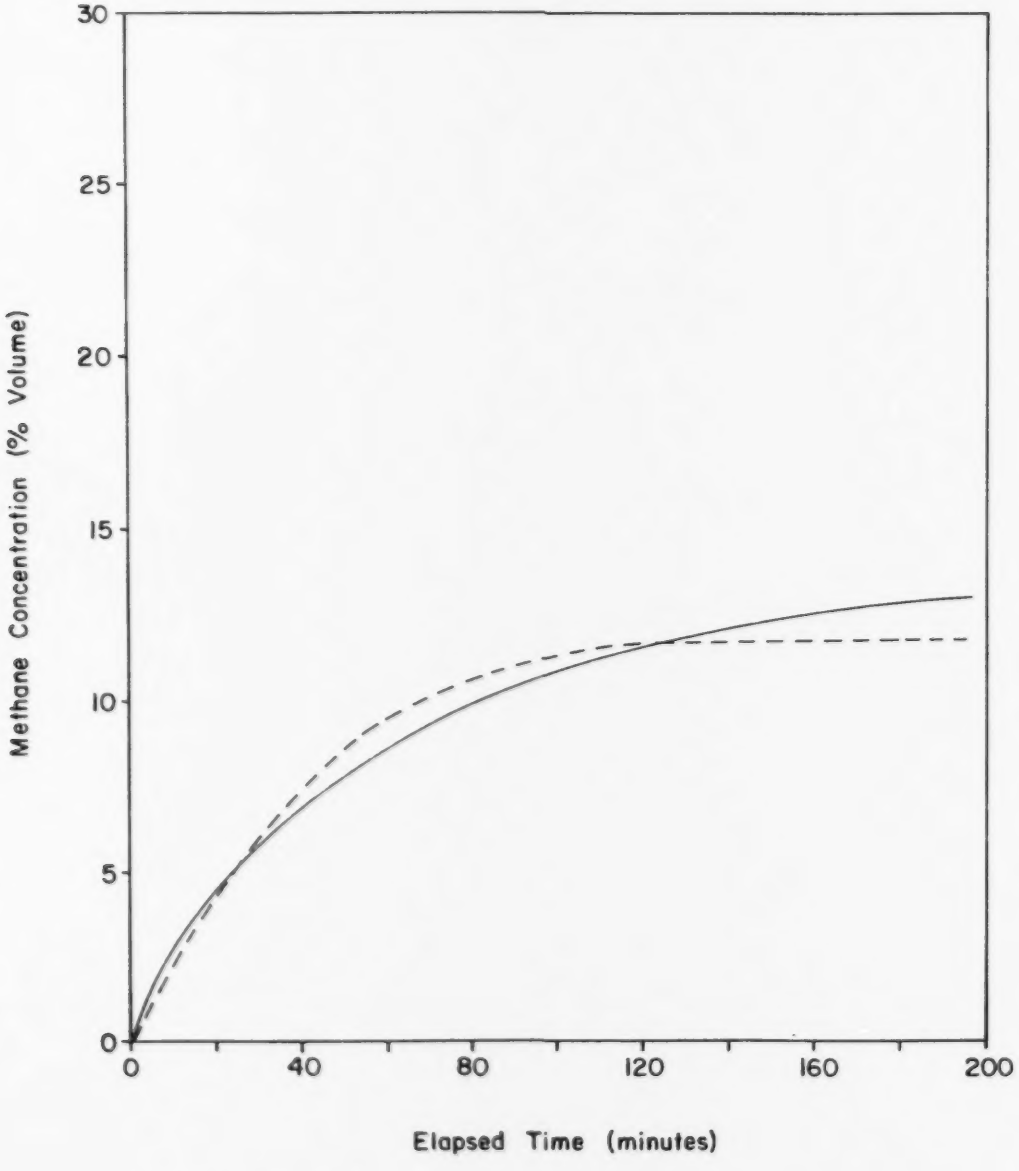

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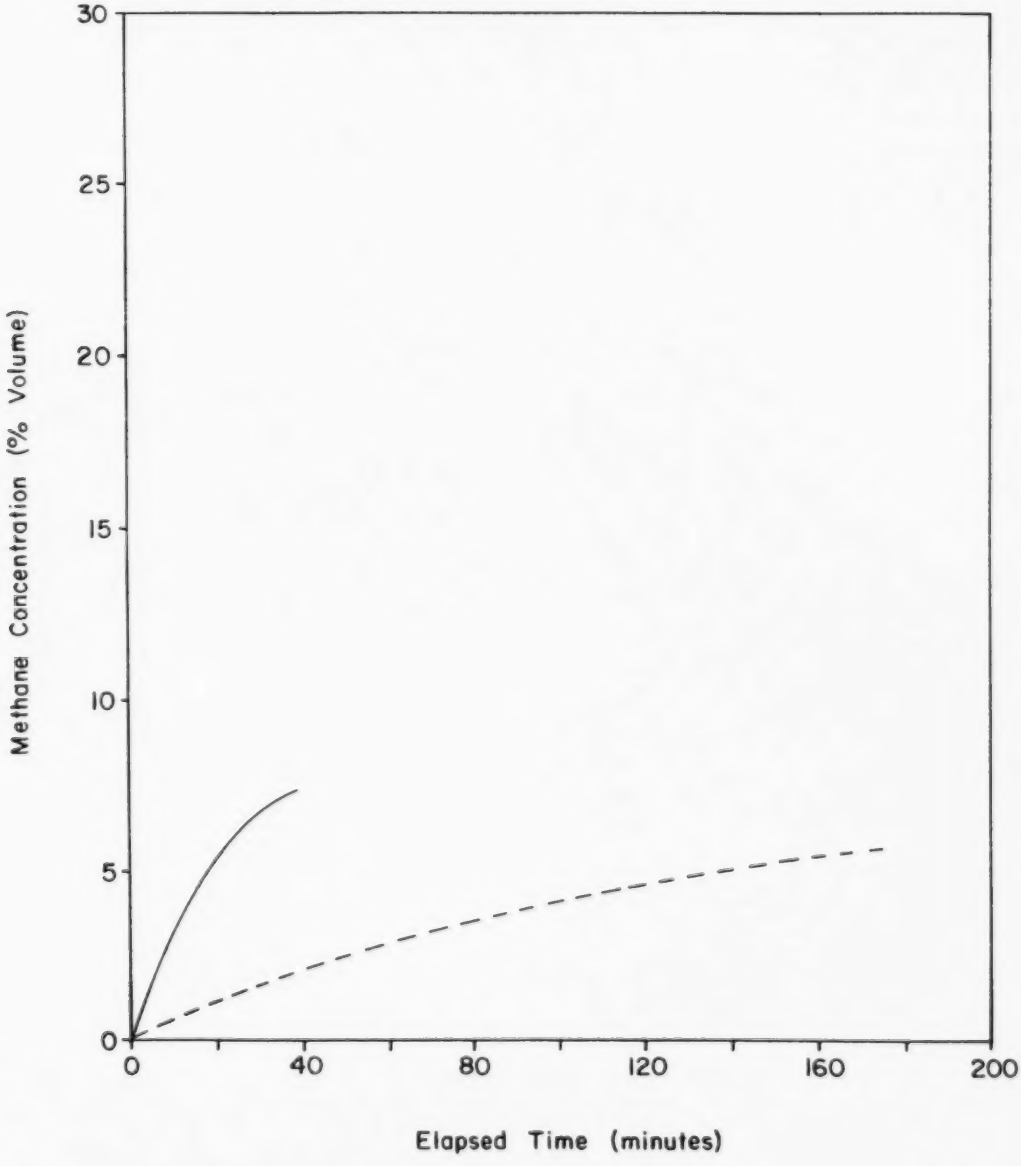
FIGURE 4-10

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

PREDICTED AND ACTUAL ACCUMULATION OF METHANE (Zero Time Base) - Mine I - Clean Metallurgical

Mine: I
Sampling Data: July 25/26, 1985
Coal Temperature: 27°C
Coal Product: Clean Metallurgical



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SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SECTION 5 - CONCLUSIONS AND RECOMMENDATIONS

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5.2	Recommendations	5-3

SECTION 5 - CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

- Desorption tests give an indication of the potential for a hazard due to methane within the mining transportation and preparation operations. The survey showed that to mitigate the hazards efficient monitoring and ventilation is required. This is especially necessary at closed transfer points, transfer tunnels, above the coal in the silo and in loadout tunnels and bins.

- The procedures for desorption tests as carried out in the survey can be performed at the minesite by quality control personnel at minimal incremental cost.

- The desorption tests in four of the seven coals generated a prediction of methane within the voids in the product in the silo similar to that actually measured.

- The rate of desorption increased significantly when coal was broken. Two coals did not generate gas in the desorption test. These coals also had a very low methane content in the voids in the silo. The tests indicate that it is impractical to make general assumptions for any coal. Each mine and different coal at the mine should be examined separately.

- In all cases the methane level within the voids remained at a constant level within the limits of accuracy of the survey soon after being covered. The atmosphere above the 0.25 m above the coal to the top of the silo in all but one case had very low

methane contents, generally in the region of 0.5% or less. The mine with the higher reading was in the process of installing additional ventilation.

- The interface between the product and the silo atmosphere varied in methane content especially when the silo was discharging. In certain cases the low oxygen content at the interface rendered the mixture below known explosive limits but with the convection currents observed within the silos, this level of oxygen cannot be guaranteed.

Explosive Mixtures

The potential for explosive mixtures are shown in Figures D-1 to D-14 in Appendix D. The results of each survey are plotted with reference to the 'Coward Triangle'. It should be noted that the **'triangle' as shown, does not take into account the effect of coal dust,** which is known to lower the explosive limit at various concentrations, or gases other than methane, oxygen and nitrogen.

Mine A

The low oxygen levels measured in the voids in the silo render the mixture inert. There is a possibility that the release of methane during treatment could be diluted by air and be in the explosive range.

Mine B

The mine was not in operation at the time of the survey.

Mine C

After treatment the mixture in the voids is within the explosive limits.

Mine D

Generally the mixture within the voids is rendered inert by the low oxygen content. However, on dilution with air an explosive interface may occur.

Mine E

After treatment the low oxygen and methane content rendered the mixture inert within the pile.

Mine F

The mixture in the voids passed through the explosive range.

Mine H

The mixture in the voids passed through the explosive range.

Mine I

The low oxygen content mainly kept the mixture inert. If air was introduced, then the methane would be within the explosive range.

5.2 RECOMMENDATIONS

- It is recommended that all operators be made aware that there is a potential hazard of an explosive mixture both within a coal silo,

in loadouts and where there are unventilated covered areas within the transport system.

- All mines test their product for desorption at regular intervals, especially where breakage is likely to occur.

- A study be instigated to establish the emission of methane from the stages of exploration to saleable product.

- Effective hot coal detectors be installed to prevent hot coal being a potential source of ignition.

- Methane monitors be installed in areas identified to be potentially hazardous. Such monitors to be tested and maintained and to report directly to the manned coal preparation operational control centre. The monitors should be sequenced to provide warning alarms at appropriate levels and to isolate electrical power before an explosive limit is reached.

- The scrubber and ventilation fans and ventilating system to be included in the preventative maintenance plan for the mine. (This is already in effect at the mines visited).

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APPENDIX A

Methane Desorption Test Results

TABLE A-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Raw Metallurgical
Sampling Date: August 15, 1985
Sample Weight: 1.723 kg
Sample Temperature: 28°C
Bulk Density: 1000 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
10	3	1.7	10.2	0.7
20	9	5.2	20.5	2.0
30	14	8.1	17.1	3.0
40	19	11.0	17.1	4.1
50	23	13.4	13.7	4.9
60	27	15.7	13.7	5.7
70	30	17.4	10.2	6.3
85	39	22.6	20.9	8.0
105	39	22.6	0.0	8.0
195	47	27.3	3.1	9.5
283	58	33.7	4.3	11.5
825*	47	27.3	-0.7	9.5
915*	47	27.3	0.0	9.5

* Temperature Drop to 19°C

TABLE A-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Raw Metallurgical
Sampling Date: August 15, 1985
Sample Weight: 1.557 kg
Sample Temperature: 28°C
Bulk Density: 1000 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
10	8	5.1	30.2	1.9
20	13	8.4	18.9	3.1
30	18	11.6	18.9	4.3
40	23	14.8	18.9	5.4
50	27	17.3	15.1	6.3
60	29	18.6	7.6	6.7
70	32	20.6	11.3	7.3
80	35	22.5	11.4	8.0
100	38	24.4	5.9	8.6
190	48	30.8	4.3	10.6
278	56	36.0	3.5	12.2
820*	41	26.3	-1.1	9.2
910*	41	26.3	0.0	9.2

* Temperature Drop to 19°C

TABLE A-3
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Clean Metallurgical (Truck Loadout)
Sampling Date: August 16, 1985
Sample Weight: 1.551 kg
Sample Temperature: 46°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	28	18.1	72.2	5.0
30	47	30.3	49.0	8.0
45	60	38.7	33.5	10.0
60	71	45.8	28.4	11.7
75	74	47.7	7.7	12.1
90	78	50.3	10.3	12.7
105	79	50.9	2.6	12.8
165	80	51.6	0.7	13.0
225	80	51.6	0.0	13.0

TABLE A-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Clean Metallurgical (Truck Loadout)
Sampling Date: August 16, 1985
Sample Weight: 1.477 kg
Sample Temperature: 46°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	34	23.0	92.1	6.2
30	50	33.9	43.3	8.9
45	63	42.7	35.2	11.0
60	70	47.4	19.0	12.0
75	74	50.1	10.8	12.6
90	77	52.1	8.1	13.1
105	78	52.8	2.7	13.2
165	78	52.8	0.0	13.2
225	78	52.8	0.0	13.2

TABLE A-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Clean Metallurgical (Train Loadout)
Sampling Date: August 16, 1985
Sample Weight: 1.561 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.235

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
10	1	0.6	3.8	0.2
55	4	2.6	2.7	0.9
115	7	4.5	1.9	1.6
175	8	5.1	0.6	1.8
235	8	5.1	0.0	1.8

TABLE A-6
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: A
Coal Type: Clean Metallurgical (Train Loadout)
Sampling Date: August 16, 1985
Sample Weight: 1.702 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
10	1	0.6	3.5	0.2
55	4	2.4	2.4	0.7
115	7	4.1	1.8	1.2
175	8	4.7	0.6	1.3
235	8	4.7	0.0	1.3

TABLE A-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: B
Coal Type: Raw
Sampling Date: July 18, 1985
Sample Weight: 1.674 kg
Sample Temperature: 25°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.36

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
3	7	4.2	84.0	1.2
8	14	8.3	49.2	2.3
13	21	12.5	50.4	3.5
18	28	16.7	50.4	4.6
23	33	19.7	36.0	5.4
28	39	23.2	42.0	6.3
33	43	25.7	30.0	6.9
47	53	31.6	25.6	8.4
57	60	35.8	25.2	9.4
67	67	40.0	25.2	10.4
77	74	44.2	25.2	11.3
87	80	47.7	21.0	12.1
132	102	60.9	17.6	15.0
147	117	70.0	36.4	16.8
162	124	74.0	16.0	17.6
282	163	97.0	11.5	21.9

TABLE A-8
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: B
Coal Type: Clean
Sampling Date: July 18, 1985
Sample Weight: 1.355 kg
Sample Temperature: 25°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
5	3	2.2	26.4	0.6
10	4	3.0	9.6	0.9
15	6	4.4	16.8	1.3
20	6	4.4	0.0	1.3
25	7	5.2	9.6	1.5
30	8	6.0	9.6	1.7
35	8	6.0	0.0	1.7
39	9	6.6	9.0	1.9
49	10	7.4	4.8	2.1
59	11	8.1	4.2	2.3
69	12	8.8	4.2	2.5
79	13	9.6	4.8	2.7
89	14	10.3	4.2	2.9
134	15	11.0	0.9	3.1
149	16	11.8	3.2	3.3
164	17	12.5	2.8	3.5
284	17	12.5	0.0	3.5

TABLE A-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Raw Metallurgical
Sampling Date: June 13, 1985
Sample Weight: 1.810 kg
Sample Temperature: 18°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
30	75	41.4	82.8	9.2
60	128	70.7	58.6	14.7
90	174	96.1	50.8	19.0
190	273	150.8	32.7	26.9
250	278	153.6	2.8	27.2
310	278	153.6	0.0	27.2
557	278	153.6	0.0	27.2

TABLE A-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Raw Metallurgical
Sampling Date: June 13, 1985
Sample Weight: 1.679 kg
Sample Temperature: 18°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
30	19	11.3	22.6	2.7
60	39	23.2	23.8	5.4
90	40	23.6	0.8	5.4
190	42	25.0	0.8	5.7
250	45	26.8	1.8	6.1
310	45	26.8	0.0	6.1
557	45	26.8	0.0	6.1

TABLE A-11
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Clean Metallurgical
Sampling Date: June 13, 1985
Sample Weight: 1.583 kg
Sample Temperature: 18°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
30	22	13.9	27.8	3.3
60	38	24.0	20.2	5.5
94	47	29.7	10.0	6.7
124	56	35.4	11.4	8.0
214	71	44.9	6.3	9.9
274	78	49.2	4.3	10.7
334	83	52.4	3.2	11.3
580	100	63.2	2.6	13.3

TABLE A-12
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Clean Metallurgical
Sampling Date: June 13, 1985
Sample Weight: 1.341 kg
Sample Temperature: 35°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
30	33	24.6	49.2	5.7
60	51	38.0	26.8	8.5
90	62	46.6	17.2	10.2
128	72	53.7	11.7	11.6
218	87	64.9	7.5	13.7
278	96	71.6	6.7	14.9
338	100	74.4	2.8	15.3
583	116	86.5	3.0	17.4

TABLE A-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Clean Metallurgical
Sampling Date: September 10, 1985
Sample Weight: 1.408 kg
Sample Temperature: 38°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
5	30	21.3	266.3	4.9
10	54	38.4	213.8	8.6
15	78	55.4	212.5	11.9
20	99	70.3	186.3	14.6
25	107	76.0	71.3	15.6
30	128	90.9	186.3	18.1
35	151	107.2	203.8	20.7
40	159	112.9	71.3	21.6
45	172	122.2	116.3	22.9
50	191	135.7	168.8	24.8
60	220	156.3	121.2	27.6
70	241	172.1	92.9	29.5
80	259	185.0	75.9	31.1
91	279	199.3	78.1	32.7
100	297	212.1	84.7	34.1
108	305	217.9	43.6	34.7
137	333	237.9	39.5	36.7
242	398	284.3	26.3	40.9

TABLE A-14
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: C
Coal Type: Clean Metallurgical
Sampling Date: September 10, 1985
Sample Weight: 1.335 kg
Sample Temperature: 38°C
Bulk Density: 881 kg/m^3
Specific Gravity: 1.38

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
5	20	15.0	187.5	3.5
10	39	29.2	177.5	6.6
15	54	40.4	140.0	9.0
20	68	50.9	131.3	11.0
25	79	59.2	103.8	12.6
30	94	70.4	140.0	14.6
35	108	80.9	131.3	16.5
40	118	88.4	93.8	17.7
50	131	98.1	57.1	19.3
60	143	107.1	52.9	20.7
70	152	113.9	40.0	21.7
80	161	120.6	39.4	22.7
91	168	125.8	28.9	23.5
100	176	131.8	40.0	24.3
108	182	136.3	33.8	24.9
137	184	137.8	3.1	25.1
242	201	150.6	7.3	26.8

TABLE A-15
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: D
Coal Type: Raw Thermal
Sampling Date: May 27, 1985
Sample Weight: 0.888 kg
Sample Temperature: 20°C
Bulk Density: 1041 kg/m^3
Specific Gravity: 1.428

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
60	3	3.4	3.4	1.3
120	5	5.6	2.3	2.1
180	7	7.9	2.3	2.9
240	10	11.3	3.4	4.1
300	12	13.5	2.3	4.9
360	13	14.6	1.1	5.3
420	14	15.8	1.1	5.7
480	14	15.8	0.0	5.7
540	14	15.8	0.0	5.7

TABLE A-16
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: D
Coal Type: Raw Thermal
Sampling Date: May 27, 1985
Sample Weight: 0.872 kg
Sample Temperature: 20°C
Bulk Density: 1041 kg/m^3
Specific Gravity: 1.428

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
60	2	2.3	2.3	0.9
120	4	4.6	3.4	1.7
180	5	5.7	1.1	2.2
240	6	6.9	1.2	2.6
300	7	8.0	1.2	3.0
360	8	9.2	1.1	3.4
420	8	9.2	0.0	3.4
480	8	9.2	0.0	3.4
540	6	6.9	0.0	2.6

TABLE A-17
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: D
Coal Type: Clean Thermal
Sampling Date: May 24, 1985*
Sample Weight: 1.329 kg
Sample Temperature: 40°C
Bulk Density: 1041 kg/m^3
Specific Gravity: 1.428

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0*	70	52.7	-	16.8
60	78	58.7	6.0	18.4
120	84	63.2	4.5	19.5
180	88	66.2	3.0	20.3
240	91	68.5	2.3	20.8
300	94	70.7	2.2	21.4
360	95	71.5	0.8	21.5
420	95	71.5	0.0	21.5
480	95	71.5	0.0	21.5
540	95	71.5	0.0	21.5

* Start of test May 27, 1985
(Sample sealed 69.5 hours)

TABLE A-18
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: D
Coal Type: Clean Thermal
Sampling Date: May 24, 1985*
Sample Weight: 1.321 kg
Sample Temperature: 40°C
Bulk Density: 1041 kg/m^3
Specific Gravity: 1.428

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0*	60	45.4	-	14.8
60	65	49.2	3.8	15.9
120	69	52.2	3.0	16.7
180	72	54.5	2.3	17.3
240	75	56.8	2.3	17.9
300	77	58.3	1.5	18.3
360	79	59.8	1.5	18.7
420	81	61.3	1.5	19.1
480	82	62.0	0.7	19.2
540	83	62.8	0.8	19.4
600	83	62.8	0.0	19.4
660	83	62.8	0.0	19.4

* Start of test May 27, 1985
(Sample sealed 69.5 hours)

TABLE A-19
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Raw Metallurgical
Sampling Date: July 17, 1985
Sample Weight: 1.257 kg
Sample Temperature: 18°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
14	10	8.0	34.8	2.2
33	20	16.0	25.0	4.3
47	22	17.5	6.5	4.7
75	31	24.7	15.3	6.5
106	31	24.7	0.0	6.5
121	31	24.7	0.0	6.5
146	31	24.7	0.0	6.5
165	35	27.8	9.7	7.2
194	35	27.8	0.0	7.2

TABLE A-20
SURVEY OF METHANE ACCUMULATIONS WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Raw Metallurgical
Sampling Date: July 17, 1985
Sample Weight: 1.021 kg
Sample Temperature: 18°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
15	6	5.9	23.5	1.6
34	10	9.8	12.3	2.7
48	12	11.8	8.5	3.2
76	13	12.7	2.1	3.4
108	13	12.7	0.0	3.4
123	13	12.7	0.0	3.4
148	13	12.7	0.0	3.4

TABLE A-21
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Clean Metallurgical
Sampling Date: July 18, 1985
Sample Weight: 1.312 kg
Sample Temperature: 45°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
5	5	3.8	45.6	1.0
10	10	7.6	45.6	2.1
15	13	9.9	27.6	2.7
19	17	13.0	37.2	3.5
24	21	16.0	36.0	4.3
29	24	18.3	27.6	4.9
34	26	19.8	18.3	5.2
39	28	21.3	18.0	5.6
44	30	22.9	19.2	6.0
49	32	23.4	6.0	6.1
56	34	25.9	20.8	6.7
66	37	28.2	13.8	7.3
76	39	29.7	9.0	7.7
86	42	32.0	13.8	8.2
96	45	34.3	13.8	8.7
106	47	35.8	9.0	9.1
151	56	42.7	9.2	10.7
166	61	46.5	15.2	11.5
181	63	48.0	6.0	11.8
301	75	57.2	4.6	13.8

TABLE A-22
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Clean Metallurgical
Sampling Date: July 18, 1985
Sample Weight: 1.299 kg
Sample Temperature: 45°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
5	4	3.0	36.0	0.8
10	7	5.4	28.8	1.5
15	10	7.7	27.6	2.1
20	13	10.0	27.6	2.7
25	17	13.1	37.2	3.5
30	19	14.6	18.0	3.9
35	21	16.2	19.2	4.3
40	23	17.7	18.0	4.7
45	25	19.2	18.0	5.1
50	26	20.2	14.2	5.3
57	29	22.3	17.5	5.9
67	32	24.6	13.8	6.4
77	35	27.0	14.1	7.0
87	37	28.5	9.0	7.4
97	41	31.6	18.6	8.1
107	43	33.1	9.0	8.5
152	53	40.8	10.3	10.2
163	57	43.9	17.2	10.9
182	60	46.1	6.9	11.4
302	73	56.2	5.1	13.6

TABLE A-23
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Clean Metallurgical
Sampling Date: July 17, 1985
Sample Weight: 1.239 kg
Sample Temperature: 45°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
3	-7	-5.7	-114.0	-1.6
10	-15	-12.1	-53.3	-3.5
15	-19	-15.3	-40.0	-4.5
22	-25	-20.2	-40.8	-6.0
26	-29	-23.4	-45.7	-7.0
37	-37	-29.9	-36.1	-9.1
41	-40	-32.3	-34.3	-9.9
51	-44	-35.5	-18.8	-11.0
57	-47	-37.9	-24.0	-11.8
68	-53	-42.8	-27.2	-13.6
82	-60	-48.4	-24.4	-15.6
90	-65	-52.5	-31.5	-17.2
97	-65	-52.5	0.0	-17.2
108	-77	-62.2	-53.9	-21.0

TABLE A-24
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Clean Metallurgical
Sampling Date: July 17, 1985
Sample Weight: 1.280 kg
Sample Temperature: 45°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
3	2	1.6	40.0	0.4
10	2	1.6	0.0	0.4
15	5	3.9	37.5	1.1
30	-2	-1.6	-28.0	-0.4
39	-5	-3.9	-20.0	-1.1
48	18	14.1	153.0	3.8
58	18	14.1	0.0	3.8
213	-35	-27.3	-20.5	-8.3

TABLE A-25
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: E
Coal Type: Clean Metallurgical
Sampling Date: July 17, 1985
Sample Weight: 1.280 kg
Sample Temperature: 45°C
Bulk Density: 910 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
13	-15	-11.7	-53.2	-3.4
16	-17	-13.3	-32.0	-3.9
27	-28	-21.9	-47.8	-6.5
32	-32	-25.0	-38.8	-7.5
43	-42	-32.8	-43.3	-10.1
47	-48	-37.5	-67.1	-11.7
51	-52	-40.6	-44.3	-12.8
57	-54	-42.2	-16.0	-13.4
63	-57	-44.5	-23.9	-14.2
67	-62	-48.4	-55.7	-15.6
74	-66	-51.6	-26.7	-16.8
87	-76	-59.4	-35.5	-19.9
96	-82	-64.0	-38.3	-21.8
103	-82	-64.0	0.0	-21.8
114	-91	-71.0	-38.9	-24.7

TABLE A-26
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Raw Metallurgical
Sampling Date: June 12, 1985
Sample Weight: 1.305 kg
Sample Temperature: 18°C
Bulk Density: 976 kg/m^3
Specific Gravity: 1.37

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
15	26	19.9	79.6	6.3
30	52	39.8	79.6	11.9
45	73	55.9	64.4	15.9
60	90	69.0	52.4	19.0
75	102	78.2	36.8	21.0
90	122	93.5	61.2	24.1
105	135	103.4	39.6	26.0
135	159	121.8	36.8	29.2
165	176	134.8	26.0	31.4
225	200	153.2	36.8	34.2
291	232	177.8	22.3	37.6
519	295	226.0	12.6	43.4
860	355	272.0	8.1	48.0
1394	397	304.2	3.6	50.8

TABLE A-27

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Raw Metallurgical
Sampling Date: June 12, 1985
Sample Weight: 1.285 kg
Sample Temperature: 18°C
Bulk Density: 976 kg/m^3
Specific Gravity: 1.37

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	20	15.5	62.0	5.0
30	40	31.1	62.4	9.5
45	69	53.7	90.4	15.4
60	81	63.0	37.2	17.6
75	97	75.5	50.0	20.4
90	112	87.2	46.8	22.8
105	125	97.3	40.4	24.8
135	147	114.4	34.2	28.0
165	165	128.4	28.0	30.4
225	188	146.3	17.9	33.2
293	214	166.5	17.9	36.1
521	289	224.9	15.1	43.3
861	349	271.6	8.2	48.0
1395	399	210.5	4.4	51.3

TABLE A-28
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Clean Metallurgical
Sampling Date: June 12, 1985
Sample Weight: 1.313 kg
Sample Temperature: 42°C
Bulk Density: 913 kg/m^3
Specific Gravity: 1.37

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	5	3.8	15.2	1.0
30	14	10.6	27.2	2.8
45	23	17.5	27.6	4.6
60	34	25.9	33.6	6.6
75	42	32.0	24.4	
90	48	36.5	18.0	9.1
105	53	40.4	15.6	10.0
120	59	45.0	18.4	11.0
150	66	50.0	10.0	12.0
180	73	55.6	11.2	13.2
220	77	58.6	4.5	13.8
340	88	67.0	4.2	15.5
545	106	80.7	4.0	18.1
887	106	80.7	0.0	18.1
1422	106	80.7	0.0	18.1

TABLE A-29
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Clean Metallurgical
Sampling Date: June 12, 1985
Sample Weight: 1.230 kg
Sample Temperature: 42°C
Bulk Density: 913 kg/m^3
Specific Gravity: 1.37

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
15	11	9.9	35.6	2.4
30	24	18.5	42.4	5.1
45	36	29.2	38.8	7.4
60	48	39.0	39.2	9.6
75	57	46.3	29.2	11.2
90	70	56.9	42.4	13.5
105	73	59.3	9.6	14.0
120	79	64.2	19.6	14.9
150	89	72.3	16.2	16.5
180	101	82.0	19.4	18.3
220	113	91.8	14.6	20.1
318	137	111.0	11.8	23.3
546	197	160.0	12.9	30.5
888	242	196.0	6.32	34.9
1420	294	238.0	4.74	39.4

TABLE A-30
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Clean Metallurgical
Sampling Date: September 12, 1985
Sample Weight: 1.295 kg
Sample Temperature: 42°C
Bulk Density: 913 kg/m^3
Specific Gravity: 1.37

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
5	27	20.8	260.0	5.4
10	38	30.1	116.3	7.6
15	50	38.6	106.3	9.6
20	57	44.0	67.5	10.7
25	65	50.2	77.5	12.1
30	72	55.6	67.5	13.2
40	81	62.5	40.6	14.6
50	87	67.2	27.6	15.5
60	88	68.0	4.7	15.7

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TABLE A-31
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: F
Coal Type: Clean Metallurgical
Sampling Date: September 12, 1985
Sample Weight: 1.4 kg
Sample Temperature: 42°C
Bulk Density: 913 kg/m^3
Specific Gravity: 1.37

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
5	17	12.1	151.3	3.2
10	22	15.7	45.0	4.1
15	30	21.4	71.3	5.5
20	36	25.7	53.8	6.6
25	41	29.3	45.0	7.4
30	47	33.6	53.8	8.4
40	49	35.0	8.2	8.7
50	53	37.9	17.1	9.4
60	54	38.6	4.1	9.6

TABLE A-32
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Raw Metallurgical
Sampling Date: August 13, 1985
Sample Weight: 1.6 kg
Sample Temperature: 20°C
Bulk Density: 1000 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
18	23	14.4	47.9	5.3
28	35	21.9	44.1	7.8
38	42	26.3	25.7	9.3
48	47	29.4	18.5	10.2
58	54	33.8	25.7	11.5
68	59	36.9	18.4	12.5
85	62	38.8	6.7	13.0
150	64	40.0	1.2	13.4
190	67	41.9	2.8	13.9
230	68	42.5	0.9	14.1
250	68	42.5	0.0	14.1
490	77	48.1	1.4	15.7
550	77	48.1	0.0	15.7

TABLE A-33
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Raw Metallurgical
Sampling Date: August 13, 1985
Sample Weight: 1.8 kg
Sample Temperature: 20°C
Bulk Density: 1000 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
10	24	13.3	78.4	4.9
20	32	17.8	26.2	6.4
30	38	21.1	19.6	7.5
40	42	23.3	13.1	8.3
50	46	25.6	13.1	9.0
60	49	27.2	9.8	9.5
85	52	28.9	4.0	10.0
150	54	30.0	1.0	10.4
190	58	32.2	3.3	11.1
230	60	33.3	1.7	11.4
250	60	33.3	0.0	11.4
490	69	38.3	1.3	12.9
550	69	38.3	0.0	12.9

TABLE A-34
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 14, 1985
Sample Weight: 1.5 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
20	0	0.0	0.0	0.0
40	0	0.0	0.0	0.0
55	1	0.7	2.7	0.2
85	2	1.3	1.3	0.4
140	3	2.0	0.7	0.6
210	6	4.0	1.7	1.1
355	6	4.0	0.0	1.1

TABLE A-35
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 14, 1985
Sample Weight: 1.7 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
20	0	0.0	0.0	0.0
40	0	0.0	0.0	0.0
55	0	0.0	0.0	0.0
85	0	0.0	0.0	0.0
140	0	0.0	0.0	0.0
210	0	0.0	0.0	0.0
340	1	0.6	0.3	0.2

TABLE A-36
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 18, 1985
Sample Weight: 1.54 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
10	1	0.7	3.8	0.2
20	2	1.3	3.8	0.4
30	2	1.3	0.0	0.4
40	2	1.3	0.0	0.4
65	2	1.3	0.0	0.4
85	2	1.3	0.0	0.4
160	2	1.3	0.0	0.4
220	2	1.3	0.0	0.4
280	2	1.3	0.0	0.4

TABLE A-37
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 18, 1985
Sample Weight: 1.81 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
10	0	0.0	0.0	0.0
20	1	0.6	3.2	0.2
30	1	0.6	0.0	0.2
40	2	1.1	3.2	0.3
65	2	1.1	0.0	0.3
85	2	1.1	0.0	0.3
160	2	1.1	0.0	0.3
220	2	1.1	0.0	0.3
280	2	1.1	0.0	0.3

TABLE A-38
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 17, 1985
Sample Weight: 1.72 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	3	1.7	7.0	0.5
25	3	1.7	0.0	0.5
45	3	1.7	0.0	0.5
105	3	1.7	0.0	0.5
195	4	2.3	0.4	0.7
255	5	2.9	0.6	0.8

TABLE A-39
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Metallurgical
Sampling Date: August 17, 1985
Sample Weight: 1.81 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	2	1.1	4.4	0.3
25	2	1.1	0.0	0.3
45	3	1.7	1.7	0.5
105	5	2.8	1.1	0.8
195	6	3.3	0.4	0.9
255	7	3.9	0.6	1.1

TABLE A-40
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 18, 1985
Sample Weight: 1.63 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	14	8.6	34.4	2.4
25	26	16.0	43.3	4.4
35	35	21.5	32.5	5.8
45	45	27.6	36.1	7.4
55	51	31.3	21.7	8.3
65	54	33.1	10.8	8.7
75	60	36.8	21.7	9.6
85	63	38.7	10.8	10.0
95	66	40.5	10.8	10.5
115	67	41.1	1.9	10.6
155	68	41.7	0.9	10.8
215	69	42.3	0.6	10.9
275	69	42.3	0.0	10.9

TABLE A-41
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 18, 1985
Sample Weight: 1.63 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	Cumulative Methane Desorbed (mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
15	18	11.0	44.1	3.1
25	29	17.8	39.7	4.9
35	39	23.9	36.1	6.5
45	50	30.7	39.7	8.1
55	56	24.4	21.7	9.0
65	60	36.8	14.4	9.6
75	65	39.9	18.1	10.3
85	69	42.3	14.4	10.9
95	74	45.4	18.1	11.6
115	74	45.4	0.0	11.6
155	75	46.0	1.9	11.7
215	75	46.0	0.0	11.7
275	75	46.0	0.0	11.7

TABLE A-42
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 14, 1985
Sample Weight: 1.7 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
22	-10	-5.9	-15.9	-1.7
42	-20	-11.8	-17.8	-3.5
87	-25	-14.7	-5.1	-4.4
212	-28	-16.5	-0.9	-5.0
347	-38	-22.4	-2.6	-6.9

TABLE A-43

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 14, 1985
Sample Weight: 1.6 kg
Sample Temperature: 37°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
22	-10	-6.3	-16.9	-1.8
42	-20	-12.5	-18.9	-3.7
87	-25	-15.6	-5.4	-4.7
212	-32	-20.0	-2.1	-6.1
347	-45	-28.1	-3.6	-8.8

TABLE A-44

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 17, 1985
Sample Weight: 1.81 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
10	4	2.2	13.0	0.6
20	1	0.6	-9.8	0.2
30	0	0.0	-3.2	0.0
50	0	0.0	0.0	0.0
75	1	0.6	1.3	0.2
110	-1	-0.6	0.0	-0.2
240	-7	-3.9	-1.5	-1.1
315	-12	-6.6	-2.2	-2.0

TABLE A-45
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: H
Coal Type: Clean Thermal
Sampling Date: August 17, 1985
Sample Weight: 1.81 kg
Sample Temperature: 32°C
Bulk Density: 920 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
10	5	2.8	16.2	0.8
20	3	1.7	-6.5	0.5
30	2	1.1	-3.3	0.3
50	2	1.1	0.0	0.3
75	3	1.7	1.3	0.5
110	0	0.0	-2.9	0.0
240	-4	-2.2	-1.0	-0.6
315	-8	-4.4	-1.8	-1.3

TABLE A-46
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: I
Coal Type: Raw Metallurgical
Sampling Date: July 25, 1985
Sample Weight: 1.634 kg
Sample Temperature: 18°C
Bulk Density: 929 kg/m^3
Specific Gravity: 1.35

Elapsed Time	Cumulative Methane Desorbed		Desorption Rate	Predicted Methane Concentration in Voids
(Minutes)	(Actual mL)	(mL/kg)	(mL/kg/h)	(Volume %)
0	0	0.0	-	0.0
30	21	12.9	25.7	3.7
40	39	23.9	64.8	6.6
50	50	30.6	39.6	8.4
60	62	37.9	43.2	10.2
80	82	50.2	37.1	13.0
100	103	63.0	39.0	15.8
120	120	73.4	31.5	18.0
150	141	86.3	25.7	20.4
210	178	108.9	22.7	24.5
240	187	114.4	11.0	25.4
270	207	126.7	24.5	27.4
305	218	133.4	11.6	28.4
325	224	137.1	11.2	29.0
340	227	138.9	7.3	29.3
1120	241	147.5	0.7	30.5

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TABLE A-47

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

METHANE DESORPTION TEST RESULTS

Mine: I
Coal Type: Clean Metallurgical
Sampling Date: July 25, 1985
Sample Weight: 1.361 kg
Sample Temperature: 27°C
Bulk Density: 854 kg/m^3
Specific Gravity: 1.35

Elapsed Time (Minutes)	Cumulative Methane Desorbed (Actual mL)	(mL/kg)	Desorption Rate (mL/kg/h)	Predicted Methane Concentration in Voids (Volume %)
0	0	0.0	-	0.0
30	0	0.0	0.0	0.0
40	-1	-0.7	0.0	-0.2
50	-1	-0.7	0.0	-0.2
70	0	0.0	0.0	0.0
100	7	5.1	10.3	1.2
130	15	11.0	11.8	2.5
190	25	18.4	7.4	4.1
250	33	24.3	5.9	5.4
280	37	27.1	5.9	5.9
325	38	27.9	1.0	6.1

APPENDIX B

Gas Sample Results

TABLE B-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - RAW COAL SILO

Mine: A
Sampling Date: August 15, 1985
Coal Temperature: 28°C
Coal Product: Raw Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			0.5									
1	t											
5			0.6									
6	t											
9		t										
16			0.85*	18.1	1.133	0.04	nd	nd	nd		nd	nd
17	t*			19.2	0.03	0.05	nd	nd	nd		nd	nd
26			1.0									
27	t											
28	t											
35	t*			19.1	0.031	0.05	nd	nd	nd		nd	nd
36			1.25*	17.6	1.358	0.41	nd	nd	nd		nd	nd
45	t											
46			1.3									
48		t*		19.0	0.029	0.5	nd	nd	nd		nd	nd
56	t											
58			1.35									
65	t											
67		t										
77	t											
95	t											
97		0.1										
155	t		0.3									
159	t		0.1									

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - TRUCK LOADOUT SILO

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			0.1									
2	0.15											
12	0.10		0.2									
17			0.2									
20			0.2									
21	0.1 *			19.3	0.226	0.15	nd	nd	nd		nd	nd
31	0.15											
32			0.55 *	18.8	0.819	0.39	nd	nd	nd		nd	nd
36			0.90									
37	0.15											
42	0.10											
43			2.4									
46	0.15											
47			3.2									
48		0.15										
49		0.10										
50		0.10										
51		0.10	3.8									
52	0.15	0.15										
53		0.10										
54		0.10										
56	0.15											
57			4.5 *	15.4	4.099	0.99	nd	nd	nd		nd	nd
64			5.0									
66	0.10											
73			5.5									
82	0.05											
83			5.0 *	13.8	5.376	1.12	nd	nd	nd		nd	nd
92			5.5									
93	0.05											

....Cont'd

TABLE B-2 Cont'd
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - TRUCK LOADOUT SILO

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
102	t											
103			5.5 *	12.4	5.983	1.22	0.005	nd	nd		nd	nd
112	0.05											
113			5.5									
122			5.5 *	10.88	6.840	1.33	0.008	nd	nd		nd	nd
124	t											

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-3
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - RAIL LOADOUT SILO

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			t									
4	t*			18.5	0.030	0.05	nd	nd	nd		nd	nd
8			0.35 *	19.0	0.527	0.46	nd	nd	nd		nd	nd
15	0.08		0.40									
23			0.60									
24	t											
25		t										
33			0.95									
35		t										
53			0.1									
93	t		0.2									
99	t		0.45									
107			0.75									
108	0.05											
109		t										
113	t		1.0 *	16.8	1.170	0.63	nd	nd	nd		nd	nd
124	t											
125		t										
129			1.2									
132	t											
133			1.3									
143			1.65									
144	t											
153			1.70									
155	t											
233	t		2.0 *	18.3	0.036	0.05	nd	nd	nd		nd	nd
234	t											
428			3.0									
429	t											
443			3.15									

.....Cont'd

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TABLE B-3 Cont'd
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - RAIL LOADOUT SILO

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
458			3.2									
473			3.3									
485			3.0									
489			2.6									
495			2.4									
503		t										
505			2.6									
508		0.1										
513		t	2.6									
518		0.1										
519			1.5									
521			0.5									
523			1.3									
524		0.05										
530		0.1										

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: C
Sampling Date: June 12/13, 1985
Coal Temperature: 35°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0	0.17 •			20.4	0.168	0.086	nd	nd	nd		nd	
2		0.44 •		20.3	0.441	0.041	nd	nd	nd		nd	
4			16.88 •	16.3	16.88	0.042	nd	nd	nd		nd	
223			18.96 •	14.6	18.96	0.61	nd	nd	0.013		nd	
226		0.17 •		18.7	0.172	0.037	nd	nd	nd		nd	
229	0.11 •			18.7	0.11	0.033	nd	nd	nd		nd	
295			18.38 •	15.8	18.38	0.046	nd	nd	0.008		nd	
297		0.72 •		18.6	0.715	0.052	nd	nd	nd		nd	
302	0.42 •			18.5	0.419	0.042	nd	nd	nd		nd	
335		0.50										
356		0.40										
363			6.0									
368		1.40										
369	0.30											
371			42.75 •	9.7	42.75	1.23	nd	nd	0.045		nd	
373			42.95 •	9.4	42.95	1.32	nd	nd	0.022		nd	
383	1.44 •			18.3	1.44	0.077	nd	nd	nd		nd	
386		2.20										
394	1.03 •			18.4	1.03	0.067	nd	nd	nd		nd	
396		2.30										
406	1.00 •			18.3	0.99	0.068	nd	nd	nd		nd	
1078		0.69 •		19.6	0.693	0.47	nd	nd	nd		nd	
1083	0.62 •			19.5	0.62	0.45	nd	nd	nd		nd	

• Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: C
Sampling Date: September 10, 1985
Coal Temperature: 35°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			-	-								
3			9.0	16.7								
5			14.0	15.2								
8			24.0	13.6								
11			28.0	12.3								
13			26.8*	11.5	26.8	0.17	nd	nd	nd		nd	nd
14			33.0	10.7								
18			37.0	10.4								
22			38.0	9.7								
26			38.0	9.1								
28			34.4*	8.8	34.4	0.25	nd	nd	nd		nd	nd
33			39.0	9.3								
38			39.0	9.2								
42			38.3*	7.8	38.3	0.33	nd	nd	nd		nd	nd
46			40.0	8.4								
54			41.0	8.7								
60			42.0	8.3								
65			42.0	10.0								

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-6

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: D
Sampling Date: May 22/23, 1985
Coal Temperature: 40°C
Coal Product: Clean Thermal Coal

	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
Elapsed Time (Mins)	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_4H_{10}
1290			17.0									
1291			20.0									
1298			11.0									
1300	0.5											
1308			17.0 *	2.0	17.0	0.62	0.035	0.06		0.002	0.1039	0.002
1310			8.5 *	9.0	8.5	0.15	nd	0.03		0.002	0.0841	0.002
1340		1.2										
1342		1.4 *		18.6	1.4	0.05	nd	0.03		0.002	0.0510	0.002
1344		1.2 *		18.9	1.2	0.05	nd	0.03		0.002	0.0530	0.002
1345	0.9 *			18.7	0.9	0.04	nd	0.03		0.002	0.0420	0.002
1346	1.3 *			18.7	1.3	0.05	nd	0.03		0.002	0.0460	0.002
1363	1.0											
1388			9.0									
1390	1.3	1.1										
1410			9.0									
1413		1.3										
1414	1.0											
1470	0.7		9.2 *	10.9	9.2	0.25	nd	0.03		0.002	nd	0.002
1480	0.7	1.3	7.5									
1485	0.7		5.5									
1488		1.3										
1489			6.5 - 7.5									
1490	1.8 *			17.8	1.8	0.06	nd	0.03		0.002	0.0490	0.002
1495	1.1	1.4	8.0									
1500	0.9	1.3	7.5 - 8.5									
1513			9.0									
1515	0.9	1.2										
1525	0.7	1.2										
1526			8.0 - 9.0									

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

AMCL

TABLE B-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: E
Sampling Date: July 18, 1985
Coal Temperature: 45°C
Coal Product: Clean Metallurgical Coal

	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
Elapsed Time (Mins)	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_4H_{10}
0			0.006*	19.2	0.006	0.036	nd	nd	nd		nd	
9		0.05 *		18.8	0.051	0.051	nd	nd	0.016		nd	
14	*			18.6	0.054	0.055	nd	nd	nd		nd	
16	0.05											
29		0										
73			0									
75		0										
76	0											
133			0*	18.5	nd	0.040	nd	nd	nd		nd	
143	0.15		0*	18.3	nd	0.039	nd	nd	nd		nd	
146		0.2										
149	0.15	0.2										
161	0.20		0*	18.2	nd	0.035	nd	nd	nd		nd	
167	0.30											
171	0.35											
176	0.40											
181	0.35											
192	0.40											
209	0.40	0.2										
221	0.40											
241	0.35											
246	0.25											
259	0.25											
		0.031*		17.9	0.031	0.051	nd	nd	nd		nd	

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-8

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: F
Sampling Date: June 10/11, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_4H_{10}
900			0.79 *	20.2	0.79	0.070	nd	nd	nd		nd	
910		0.94 *		19.92	0.94	0.055	nd	nd	nd		nd	
915	1.19 *			19.54	1.19	0.064	nd	nd	nd		nd	
923			1.4									
925	1.4	1.4										
940	0.7	0.5										
943			1.3									
944		0.9										
947	1.0											
955		0.9										
957			1.2									
959	2.0											
970	2.0											
972		2.1										
974			2.1									
979	3.6											
981		26.0										
985			2.6									
993		2.6										
1000	1.7											
1007			2.0									
1010	1.78 *	2.5		19.22	1.78	0.1274	nd	nd	nd		nd	
1011	1.1-1.5											
1014	2.4		2.0									
1016		2.1										
1022			2.0									
1026		2.2										
1032		2.0										
1034			1.6									
1035	1.6											

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

AMCL

TABLE B-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: F
Sampling Date: September 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air[f]	0.25 Above Coal[f]	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			0.1	19.4								
13			0.1	19.3								
23			0.1	19.3								
33			0.1	19.4								
58			0.15	19.1								
63			0.2	19.3								
68			0.8 •	17.8	0.95	0.32	nd	nd	0.046		nd	nd
73			2.0	18.4								
78			4.0	11.8								
88			7.0	15.9								
93			10.0	14.5								
103			10.0 •	17.1	1.53	0.33	nd	nd	nd		nd	nd
113			10.0	13.5								
123			10.0 •	17.0	1.65	0.30	nd	nd	nd		nd	nd

[f] CH_4 not detected above coal or silo air
• Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - RAW COAL SILO

Mine: H
Sampling Date: August 13, 1985
Coal Temperature: 20°C
Coal Product: Raw Metallurgical Coal

	Methane Concentration (% by Volume)				Gas Analysis (% by Volume)								
Elapsed Time (Mins)	Silo Air	0.25 Above Coal	In Coal		O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			2.0										
1		t											
2	t												
5			2.95										
6		0.15											
8	t												
11			3.65										
12	t	0.55											
16			4.0										
17		1.10											
18	0.05												
21			4.85										
22	t												
23		t											
25			5.0										
27		t											
28	t												
30			5.5	*	17.0	5.104	0.34	nd	nd	nd		nd	nd
34	t*				18.8	0.110	0.09	nd	nd	nd		nd	nd
40			5.4										
43		t											
47		t											
48	t												
50			2.6										
52		0.05											
58	t*				18.8	0.040	0.06	nd	nd	nd		nd	nd
59			2.8	*	18.6	0.571	0.06	nd	nd	nd		nd	nd
67			3.0										
68	t												
80			3.35										

.....Cont'd

TABLE B-10 Cont'd
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - RAW COAL SILO

Mine: H
Sampling Date: August 13, 1985
Coal Temperature: 20°C
Coal Product: Raw Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
81	t											
95	t		3.7 *	17.0	3.334	0.12	nd	nd	nd		nd	nd
103			6.0 *	16.4	6.821	0.25	nd	nd	nd		nd	nd
112	0.05 *			18.5	0.023	0.04	nd	nd	nd		nd	nd
113			7.0									
118			8.0									
119	0.05											
129			1.25									
130		0.1										
132	t											
139			4.8									
141	0.05											
143		0.1										
149			4.5 *	16.8	4.000	0.18	nd	nd	nd		nd	nd
155	t*			18.2	0.043	0.50	nd	nd	nd		nd	nd
163			4.4									
166	t											
172		0.6										
176	t											
178			5.0									
179			9.0									
181		0.1										
183			3.6									
184		0.1										
186	t											
193			3.1									
194	0.1											
195		0.2 *		18.0	0.017	0.06	nd	nd	nd		nd	nd

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-11

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: H
Sampling Date: August 14, 1985
Coal Temperature: 23°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			0.25									
8			1.5									
9	0.2											
13	0.1											
14			3.0 *	17.9	0.870	0.30	nd	nd	nd		nd	nd
19	0.15		4.1									
25	0.15											
26			4.0 *	16.8	2.320	0.65	nd	nd	nd		nd	nd
30	0.15 *			18.2	0.210	0.15	nd	nd	nd		nd	nd
34			6.5									
35	0.10											
39			7.0 *	14.1	5.920	1.47	0.003	nd	0.004		nd	nd
44	0.10											
46			7.0									
54	0.10 *			18.3	0.219	0.14	nd	nd	nd		nd	nd
56			8.0									
64	0.10											
65			9.0 *	12.6	7.43	1.77	nd	nd	nd		nd	nd
73	0.10											
74			9.5									
84	0.15 *			18.2	0.235	0.15	nd	nd	nd		nd	nd
86			10.0 *	11.5	8.668	1.98	0.003	nd	nd		nd	nd
94	0.15											
96			10.5									
106	0.15											
107			11.0									
124	0.15											
126			11.0 *	9.9	9.94	2.21	0.007	nd	nd		nd	nd
136	0.15 *			17.9	0.44	0.14	nd	nd	nd		nd	nd
139			11.5									

.....Cont'd

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TABLE B-11 Cont'd
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: H
Sampling Date: August 14, 1985
Coal Temperature: 23°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
152	0.10											
154			12.5									
163	0.20											
165			13.0 *	8.2	11.452	2.47	t	nd	nd		nd	nd
177	0.20 *			17.9	0.273	0.17	nd	nd	nd		nd	nd
180			13.0 *	8.0	11.675	2.54	t	nd	nd		nd	nd
194	0.25											
196			13.0									
207	0.2 *			17.9	0.223	0.14	nd	nd	0.015		nd	nd
211			13.0 *	7.3	12.296	2.65	0.005	nd	nd		nd	nd
237	0.2 *			6.6	13.117	2.77	nd	nd	0.015		nd	nd
239			14.0	6.6	12.882	2.74	0.003	nd	nd		nd	nd
297	0.15		15.0 *	5.4	14.334	3.00	0.012	nd	nd		nd	nd
327	0.1		16.0 *	5.0	14.639	3.13	0.002	nd	0.02		nd	nd
338			16.0									
340	0.2											
342			16.0									
343	0.2											
345			15.00*	4.9	14.660	3.13	0.003	nd	0.02		nd	nd
347	0.2											
352			15.0									
353	0.25											
358	0.3 *			17.7	0.384	0.15	nd	nd	nd		nd	nd
359			15.0 *	4.9	14.331	3.07	0.004	nd	0.019		nd	nd
366	0.25											
367			13.0 *	11.58	7.390	1.54	0.001	nd	nd		nd	nd
376	0.3											

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-12

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: H
Sampling Date: August 17, 1985
Coal Temperature: 37°C
Coal Product: Clean Metallurgical Coal

	Methane Concentration (% by Volume)				Gas Analysis (% by Volume)								
Elapsed Time (Mins)	Silo Air	0.25 Above Coal	In Coal		O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			t										
2	t												
13	t												
14			t*		18.7	0.082	0.58	nd	nd	nd		nd	nd
23			0.05										
28			0.10										
29	t												
45	t		0.15										
73			0.20										
74			0.5										
75	t												
85			0.20										
86			0.15										
88	t												
95			0.25										
97			0.20										
98	t												
105			0.30	*	14.2	0.275	1.39	0.01	nd	nd		nd	nd
110	t*				19.3	0.013	0.09	nd	nd	nd		nd	nd
111			0.25	*	14.2	0.236	1.99	0.01	nd	nd		nd	nd
200			0.4										
201	t												
223			0.45										
224			0.55										
225	t												
242		t	0.50	*	18.4	0.030	0.11	nd	nd	nd		nd	nd
243			0.55	*	9.6	0.331	2.19	0.03	nd	nd		nd	nd
244	t*				18.4	0.029	0.12	nd	nd	nd		nd	nd
261		0.05	0.60	*	5.47	0.483	3.10	0.04	nd	nd		nd	nd
270			0.30										
272		0.08											

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: H
Sampling Date: August 18, 1985
Coal Temperature: 37°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
0			t*	18.9	0.135	0.36	nd	nd	nd		nd	nd
12			t*	18.3	0.254	0.50	nd	nd	nd		nd	nd
27			t*	17.4	0.431	0.71	nd	nd	nd		nd	nd
78			1.0	14.5	0.816	1.12	nd	nd	nd		nd	nd
180			1.5	18.5	0.012	0.04	nd	nd	nd		nd	nd

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

TABLE B-14

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

GAS SAMPLE RESULTS - CLEAN COAL SILO

Mine: I
Sampling Date: July 25/26, 1985
Coal Temperature: 27°C
Coal Product: Clean Metallurgical Coal

Elapsed Time (Mins)	Methane Concentration (% by Volume)			Gas Analysis (% by Volume)								
	Silo Air	0.25 Above Coal	In Coal	O_2	CH_4	CO_2	CO	C_2H_4	C_2H_6	C_3H_8	N_2O	C_2H_2
932	0.10											
934	0.10 *			19 42	0.10	0.052	nd	nd	nd	nd	nd	
940	0.08 *			19.24	0.080	0.043	nd	nd	nd	nd	nd	
945	0.10											
949	0.0											
953			1.80 *	15.97	2.0	0.670	nd	nd	nd	nd	nd	
956		0.00										
958		0.08 *		18.71	0.081	0.043	nd	nd	nd	nd	nd	
970			4.60									
975			7.00									
976			3.0	15.43	3.0	0.756	nd	nd	nd	nd	nd	
978	0.05											
980		0.10										
985			5.00									
990		0.10										
995	0.10											
1000			6.00									
1007		0.15										
1020		0.05										
1025		0.13 *		18.27	0.13	0.054	nd	nd	nd	nd	nd	
1032	0.05											
1039			3.15									
1047		0.05										
1050	0.05											
1063		5.00										
1066			4.4 *	12.93	4.486	0.954	nd	nd	nd	nd	nd	
1072		0.05										
1075			5.00									
1083		0										
1087	0											
1088		0.25 *		18.04	0.247	0 0595	nd	nd	nd	nd	nd	
1091	0.12 *			18.14	0.129	0.0534	nd	nd	nd	nd	nd	
1095			7.8 *	9.93	7.809	1.2430	nd	nd	nd	nd	nd	

* Indicates Gas Analysis Sample Location
t Trace
nd Not Detected

APPENDIX C

Survey Results

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FIGURE C-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: A
Sampling Date: August 15, 1985
Coal Temperature 28°C
Coal Product: Raw Metallurgical

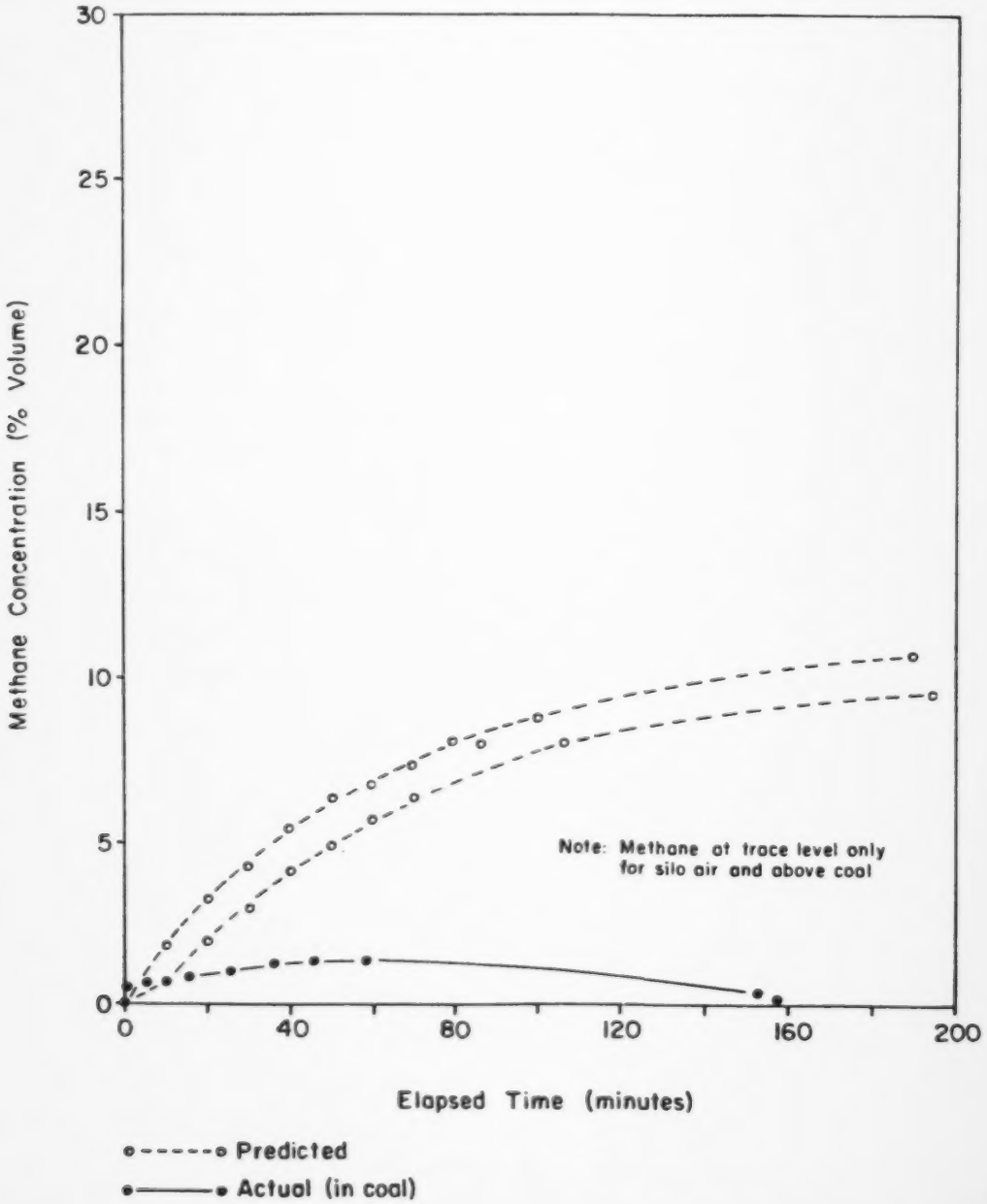

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FIGURE C-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: A
Sampling Date: August 16, 1985
Coal Temperature 46°C
Coal Product: Clean Metallurgical (Truck Loadout)

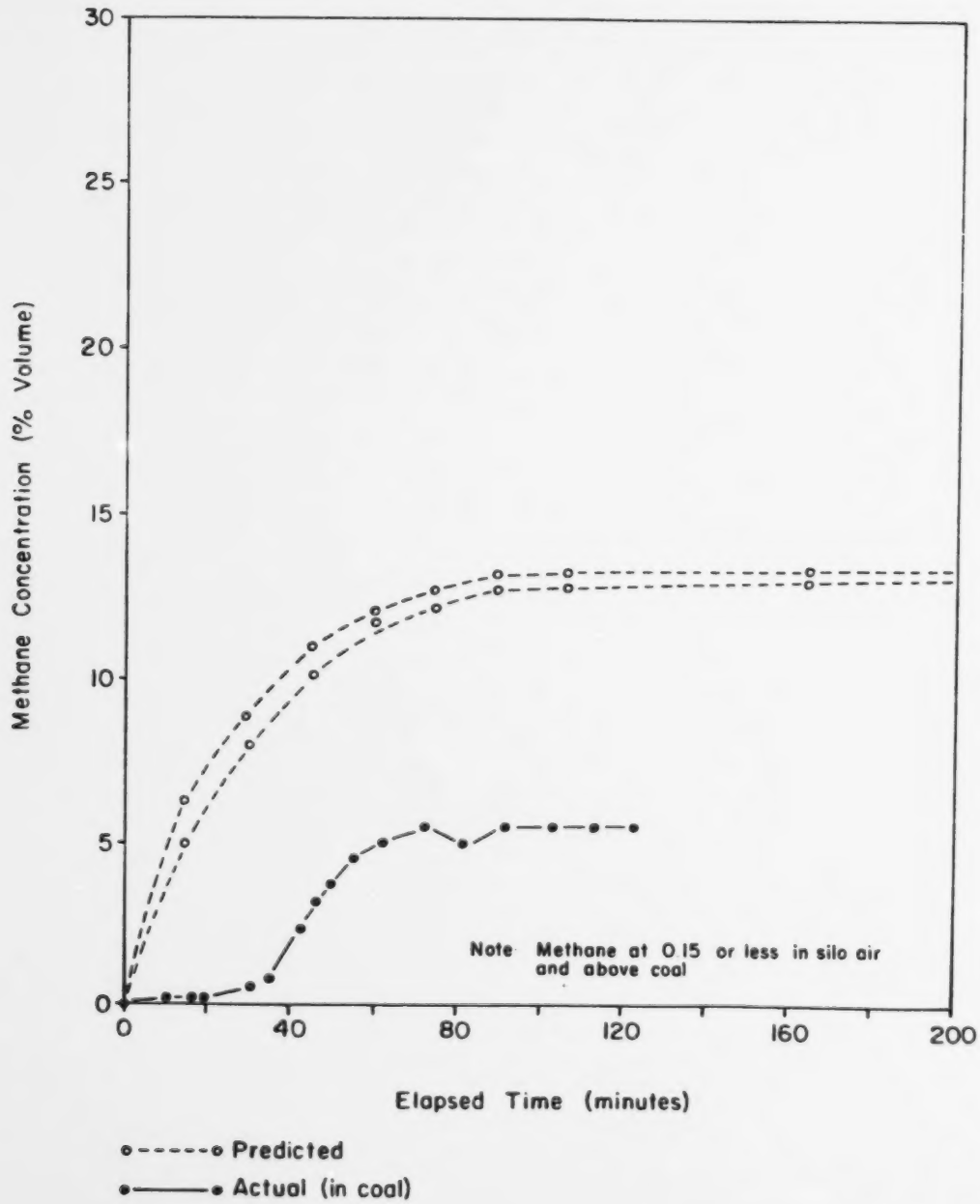

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FIGURE C-3
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: A
Sampling Date: August 16, 1985
Coal Temperature 32°C
Coal Product: Clean Metallurgical (Rail Loadout)

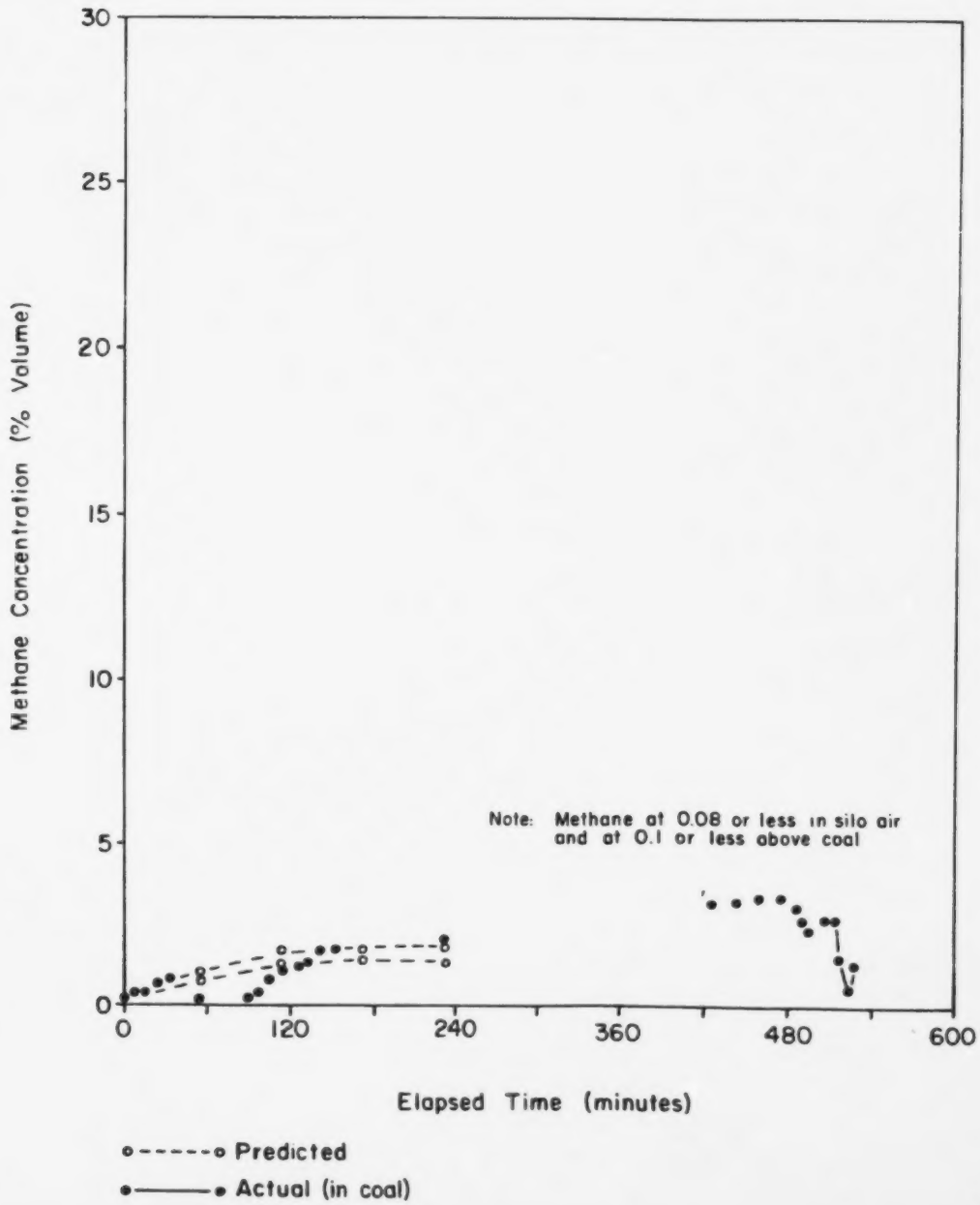

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FIGURE C-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: B
Sampling Date: July 18, 1985
Coal Temperature 25°C
Coal Type: Raw

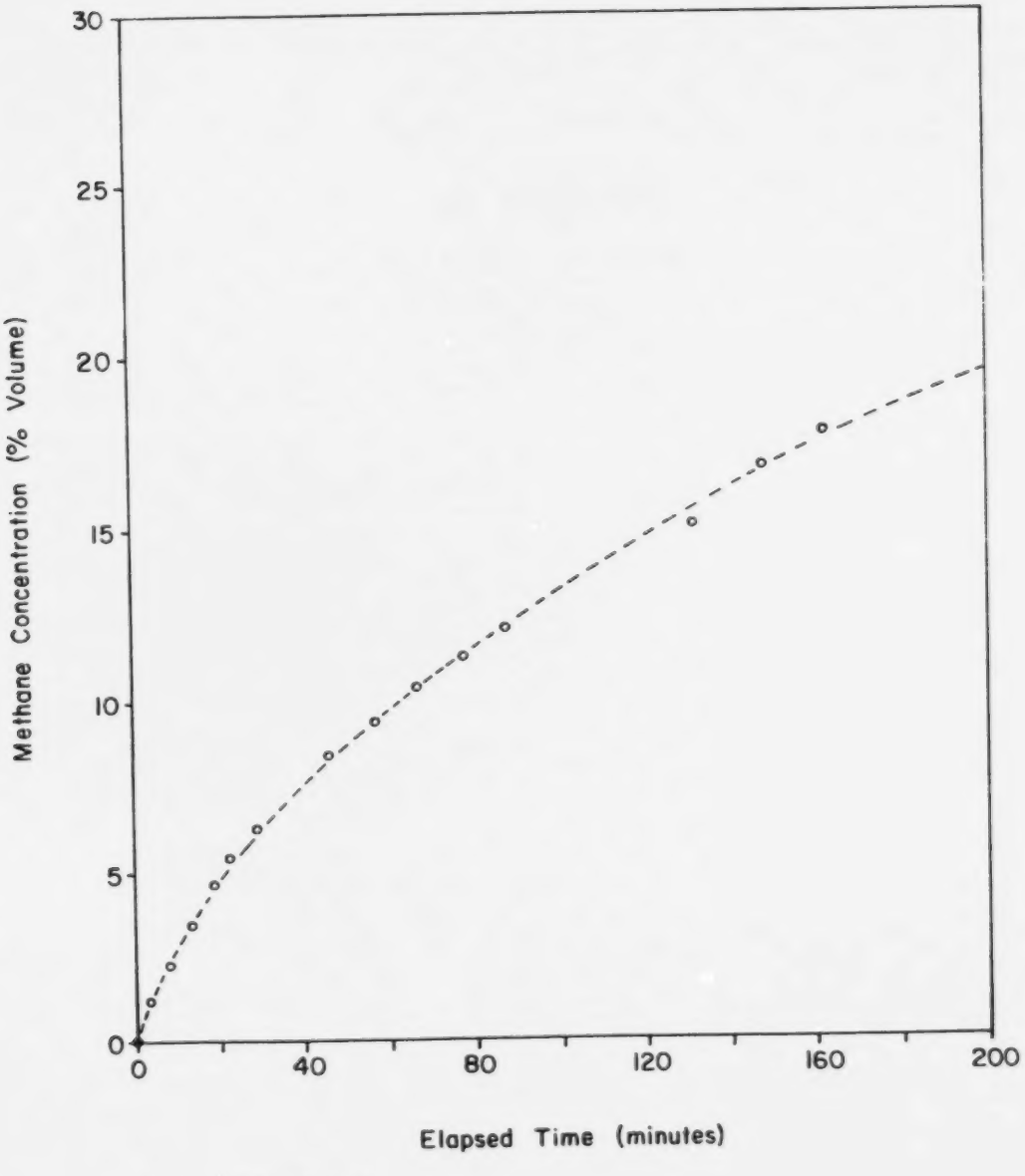

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FIGURE C-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: B
Sampling Date: July 18, 1985
Coal Temperature 25°C
Coal Product: Raw Product

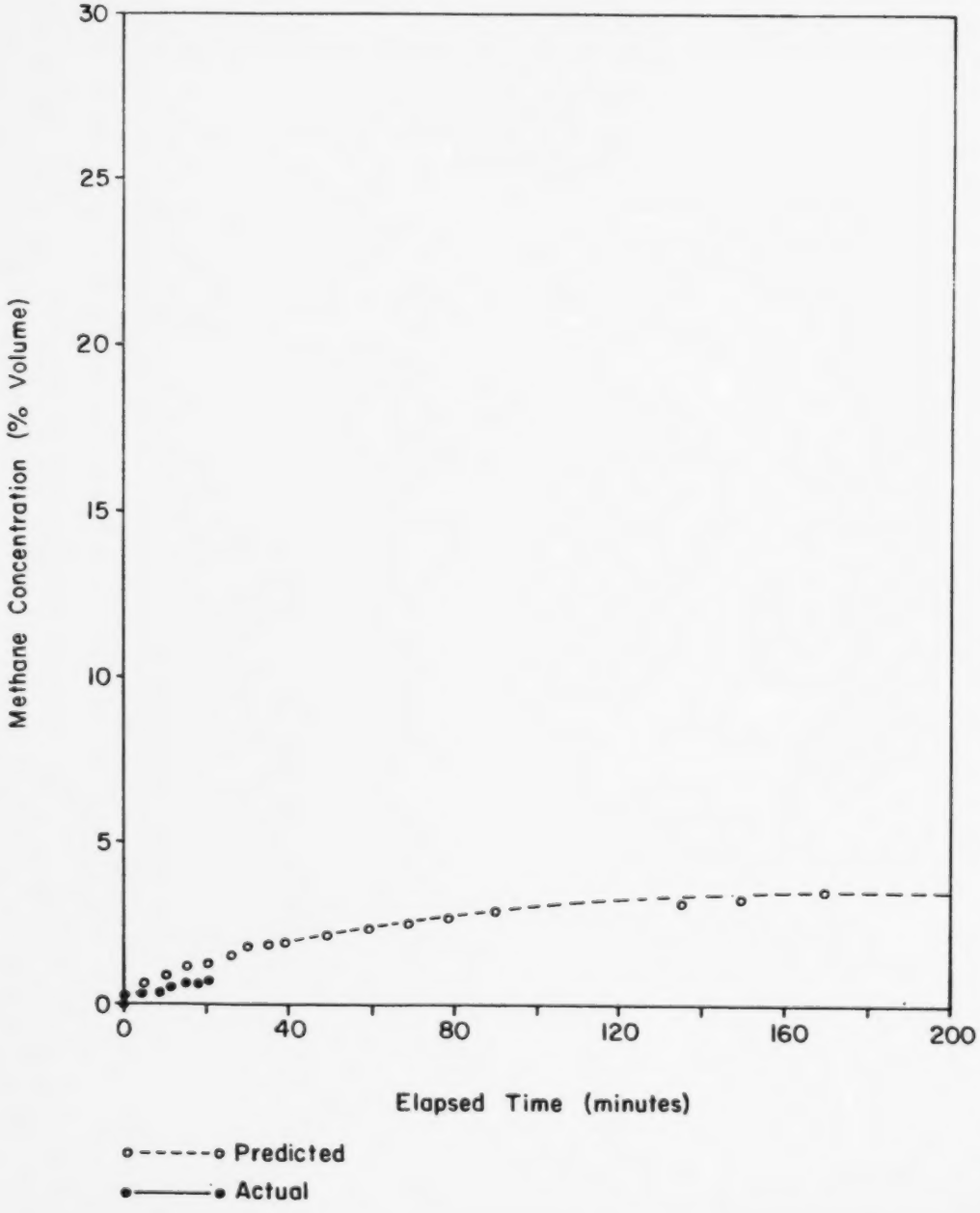

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FIGURE C-6
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: C
Sampling Date: June 13, 1985
Coal Temperature 18°C
Coal Product: Raw Metallurgical

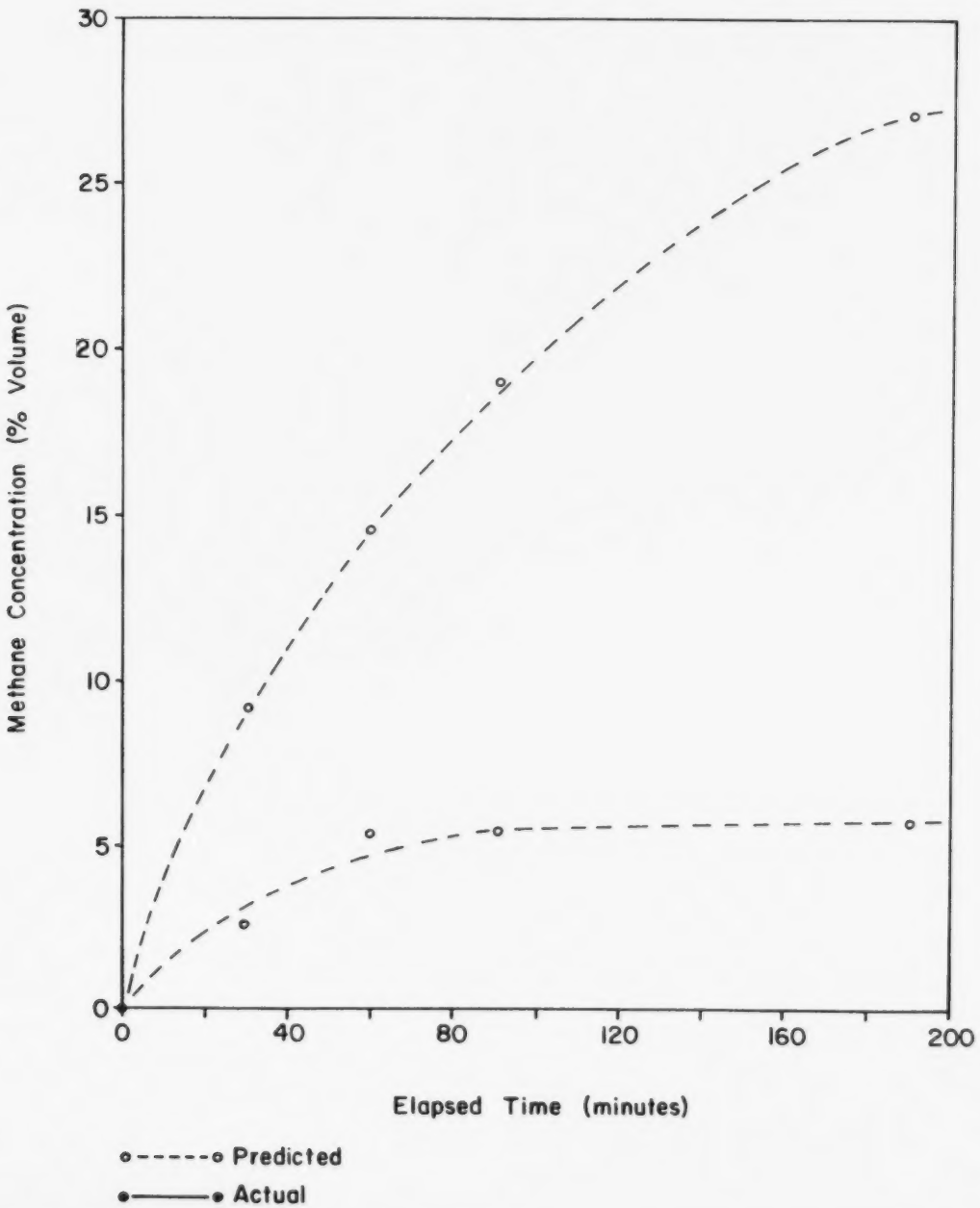

FIGURE C-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: C
Sampling Date: June 12/13, 1985
Coal Temperature 35°C
Coal Product: Clean Metallurgical

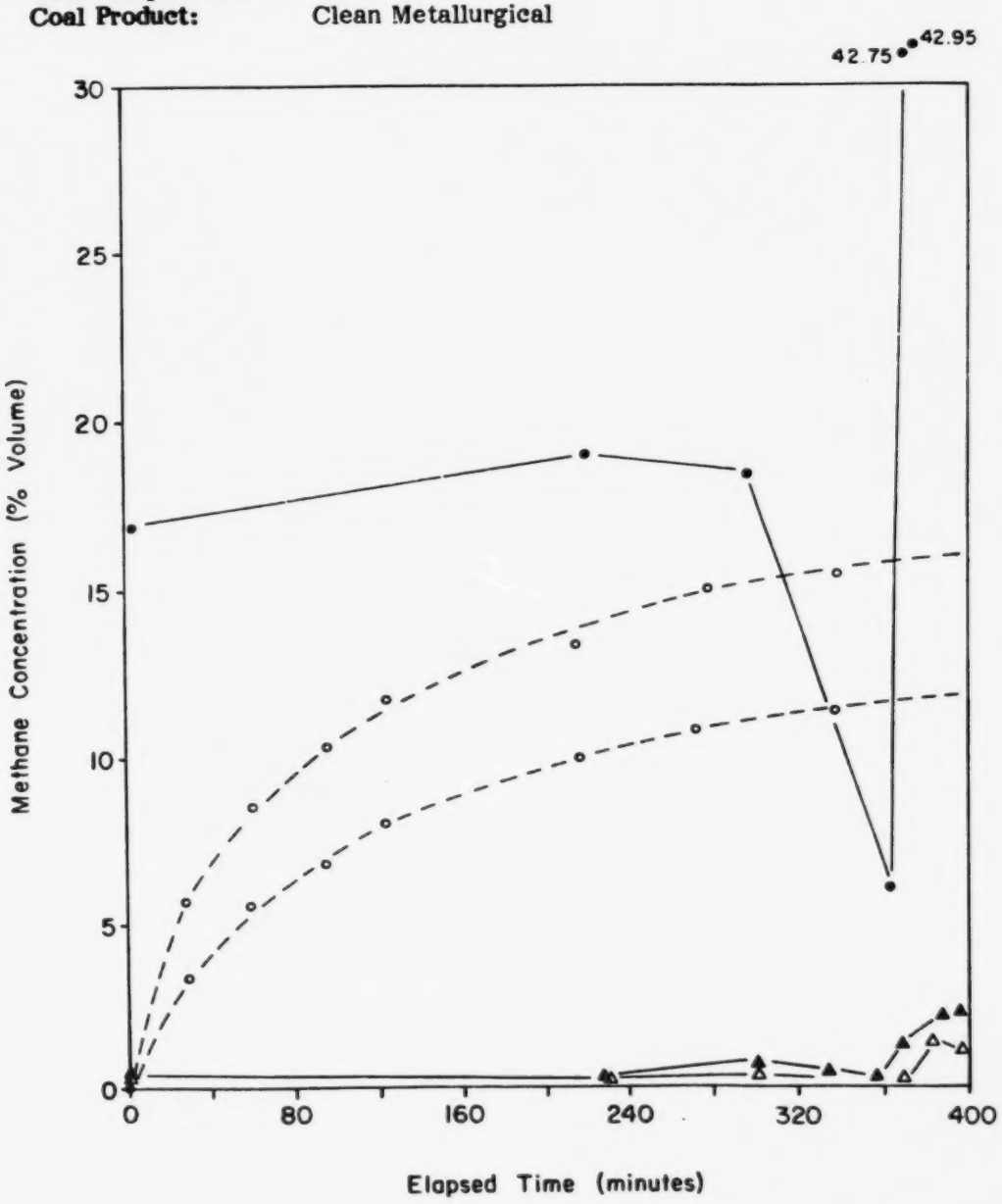

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FIGURE C-8
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: C
Sampling Date: September 10, 1985
Coal Temperature 38°C
Coal Product: Clean Metallurgical

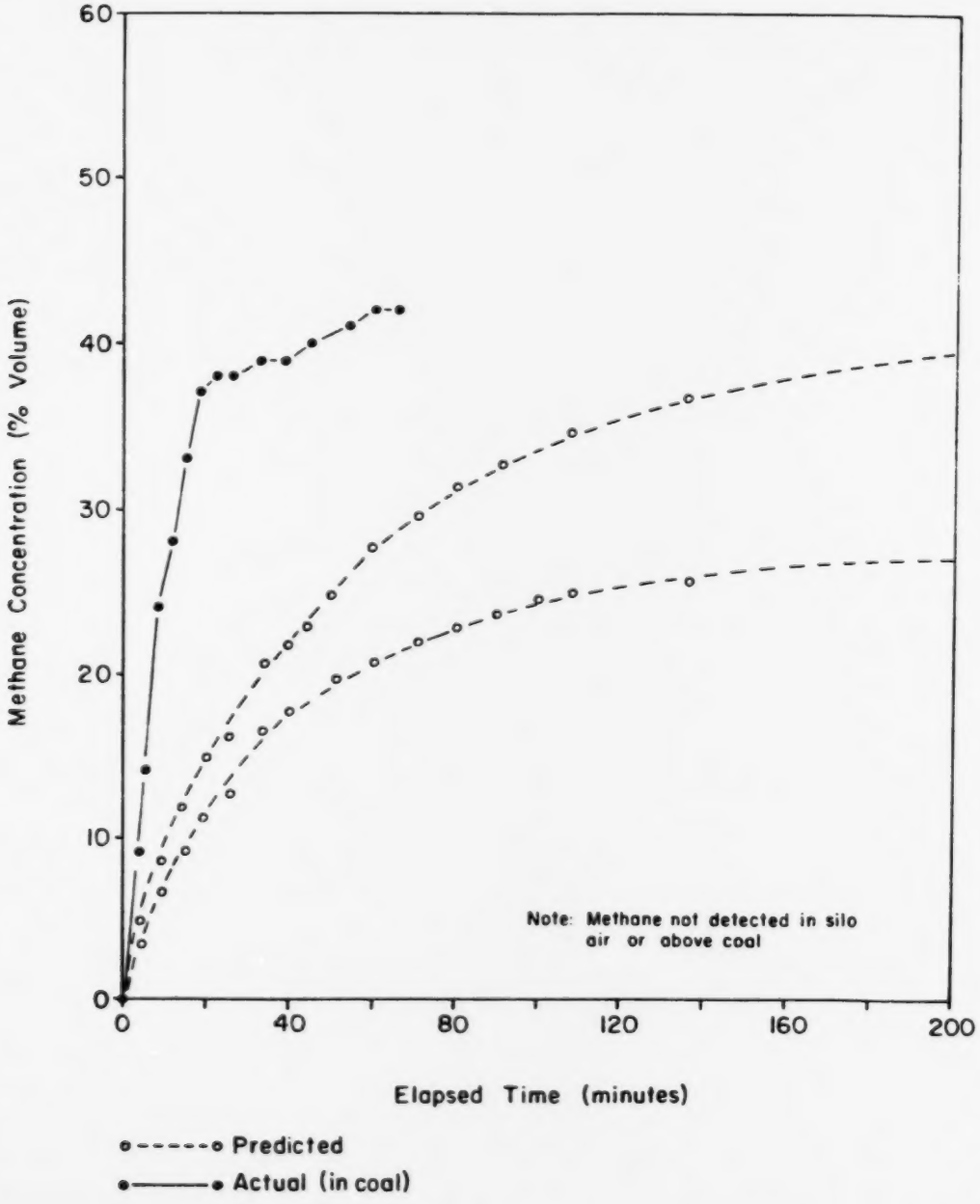

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FIGURE C-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: D
Sampling Date: May 22/23, 1985
Coal Temperature 40°C
Coal Product: Clean Thermal

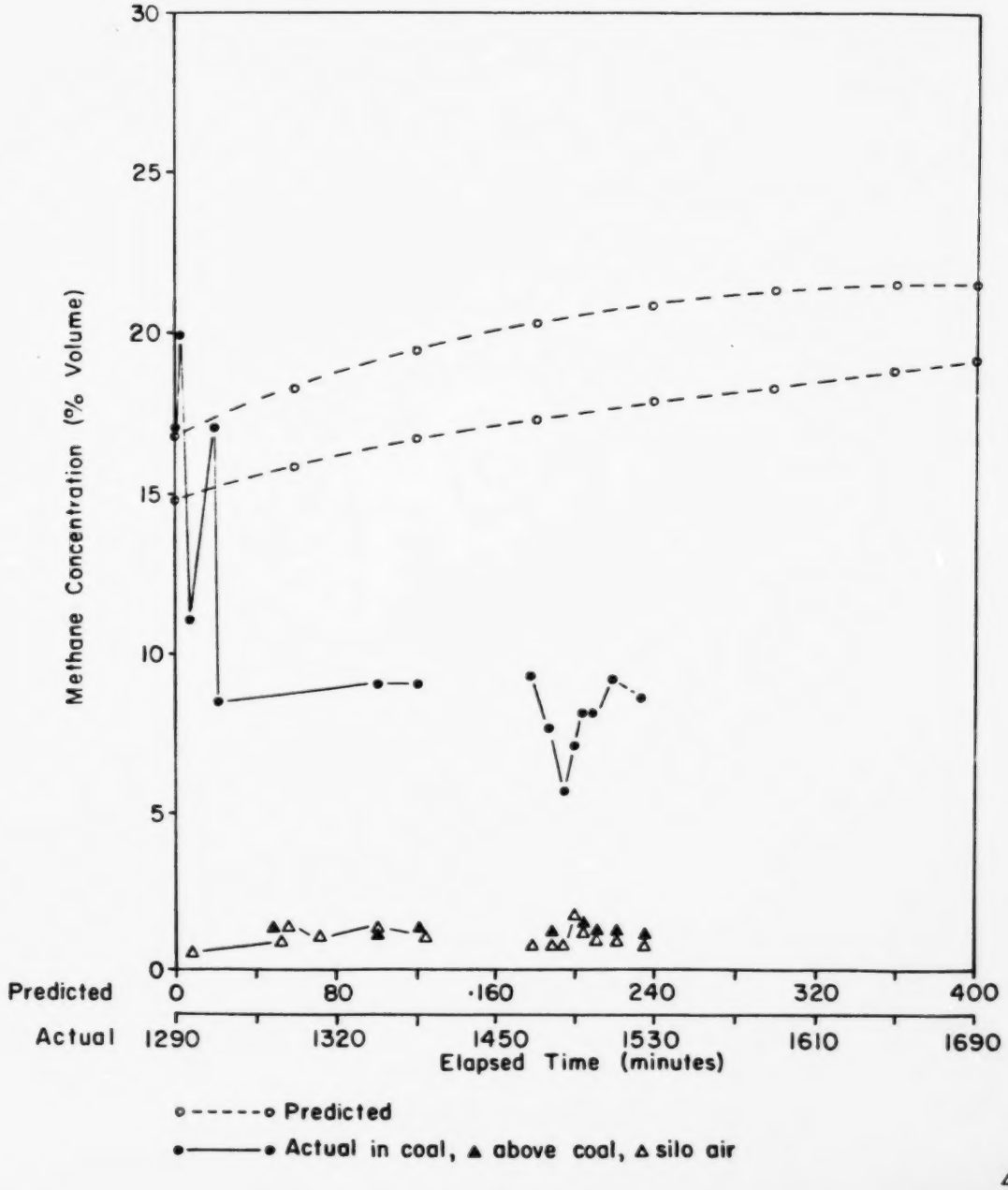

FIGURE C-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: D
Sampling Date: May 27, 1985
Coal Temperature 20°C
Coal Product: Raw Thermal

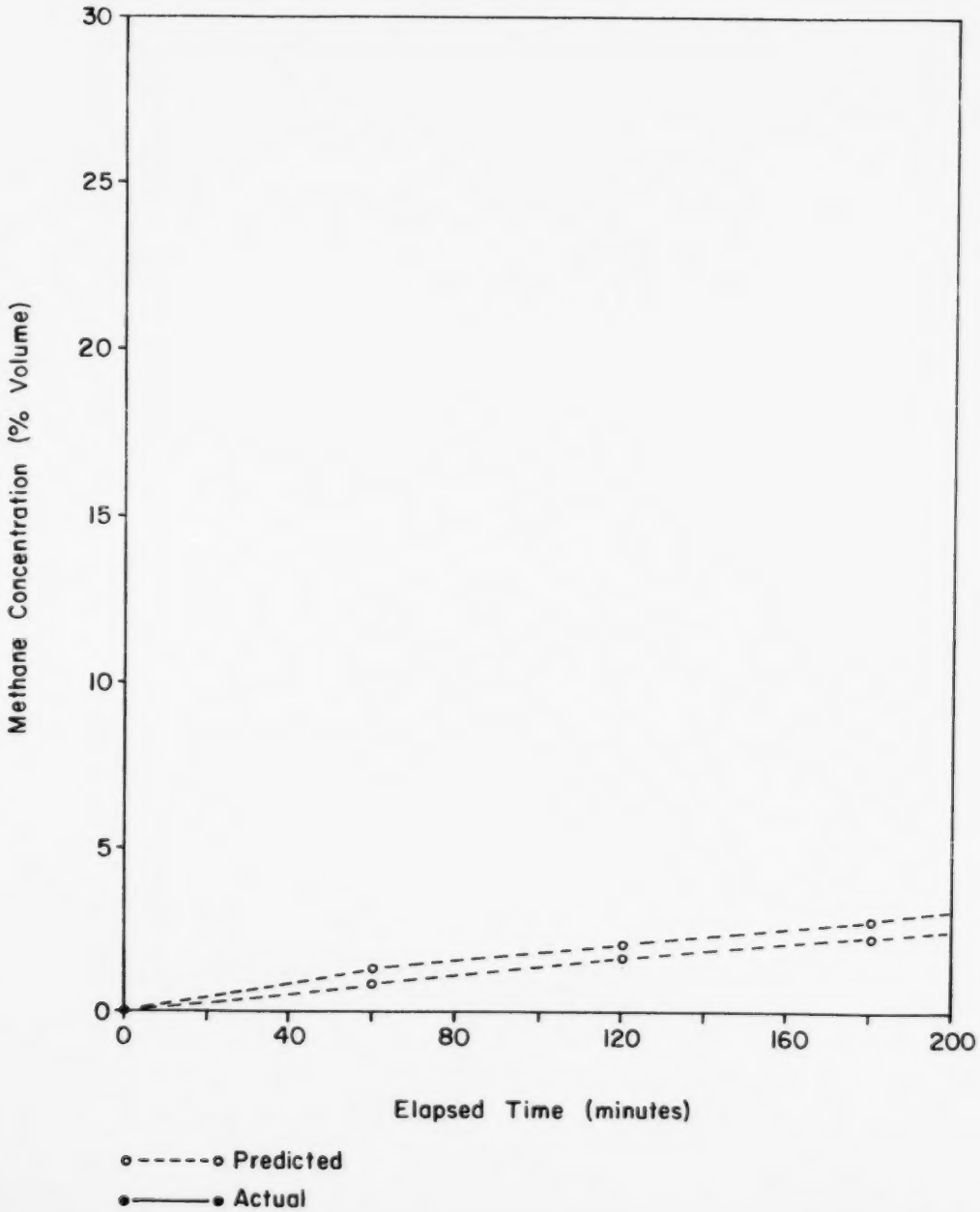

FIGURE C-11
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: E
Sampling Date: July 17, 1985
Coal Temperature 18°C
Coal Product: Raw Metallurgical

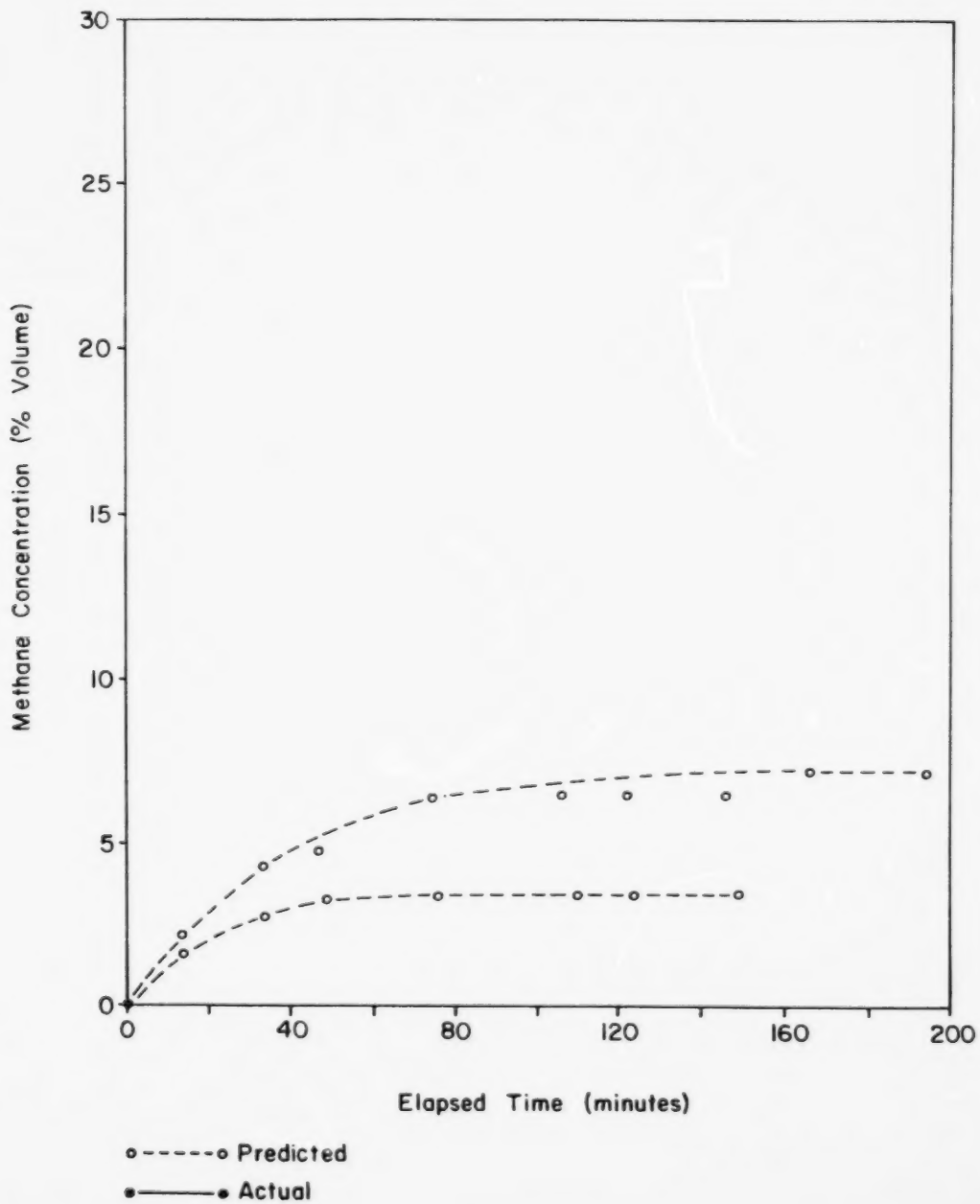

FIGURE C-12
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: E
Sampling Date: July 18, 1985
Coal Temperature 45°C
Coal Product: Clean Metallurgical

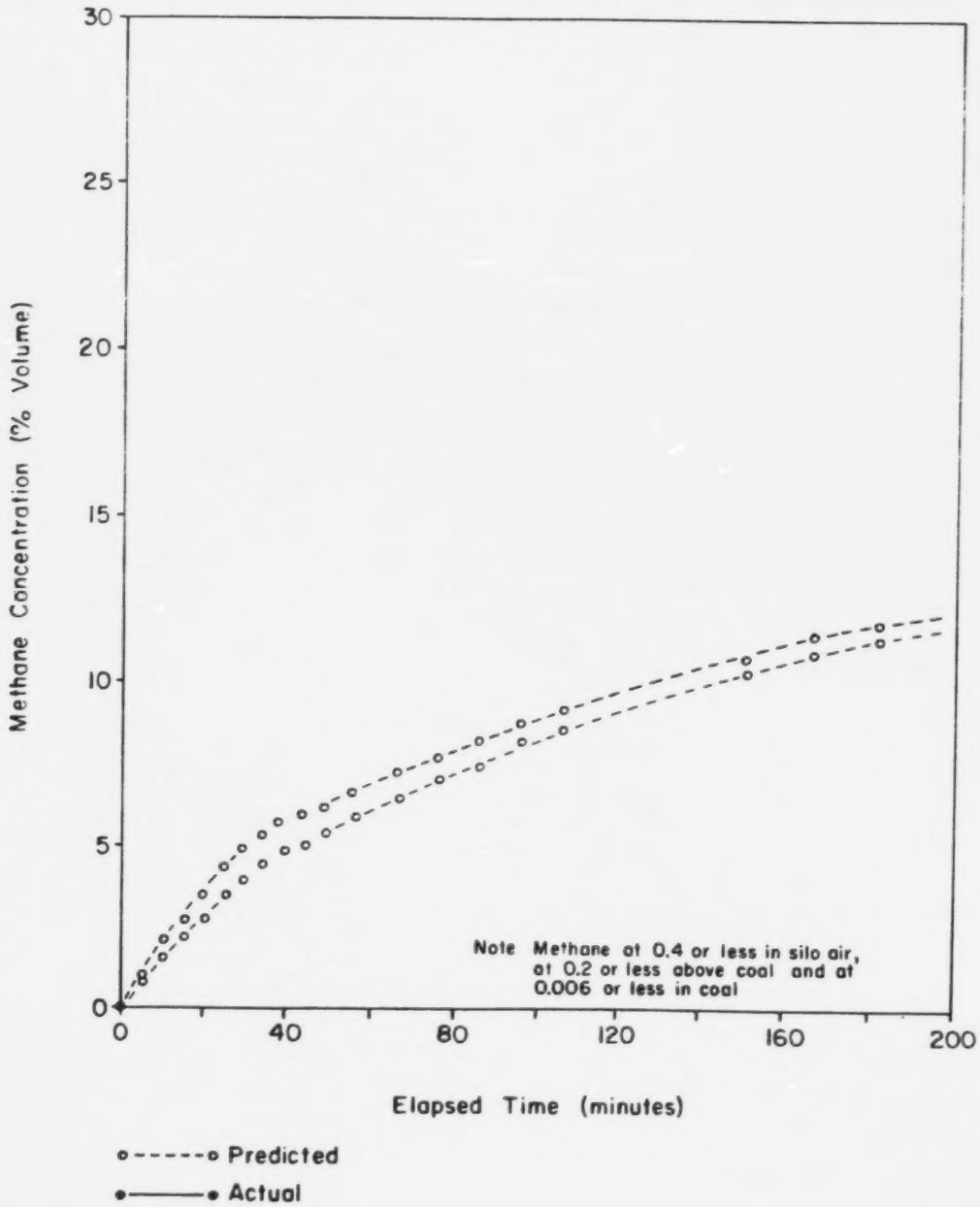

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FIGURE C-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: F
Sampling Date: June 12, 1985
Coal Temperature 42°C
Coal Product: Clean Metallurgical

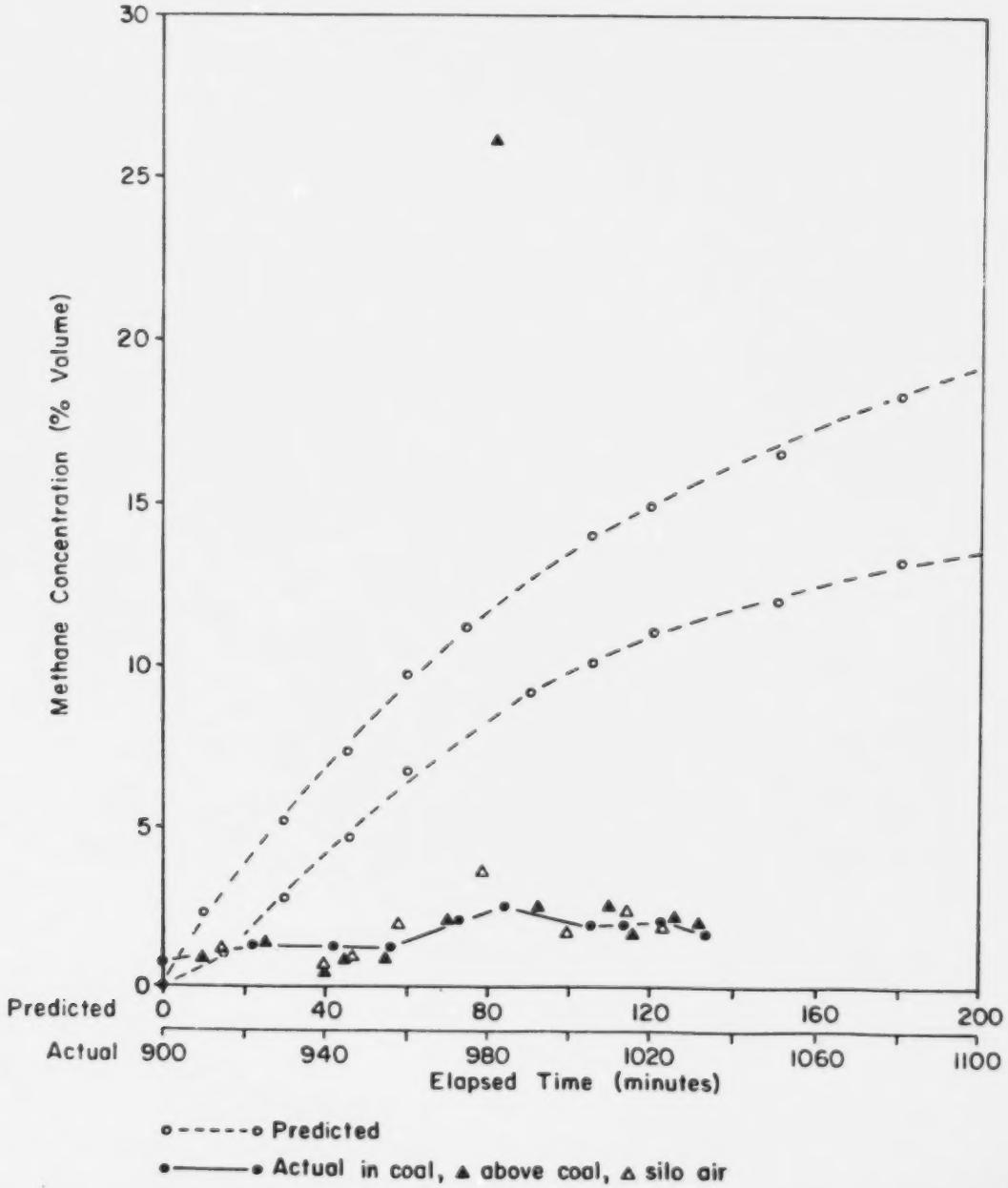

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FIGURE C-14
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: F
Sampling Date: June 12, 1985
Coal Temperature 18°C
Coal Product: Raw Metallurgical

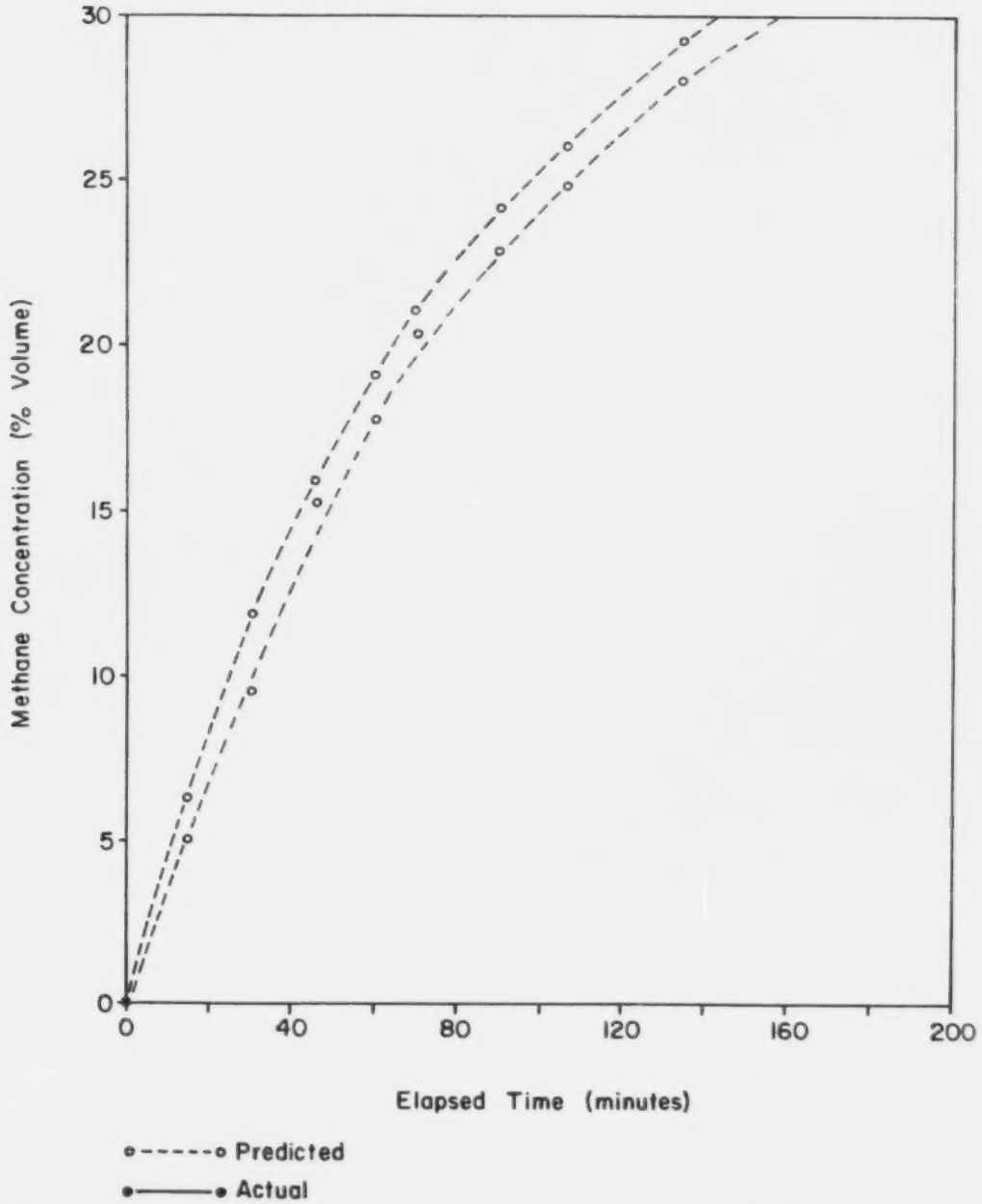

FIGURE C-15
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: F
Sampling Date: September 12, 1985
Coal Temperature 42°C
Coal Product: Clean Metallurgical

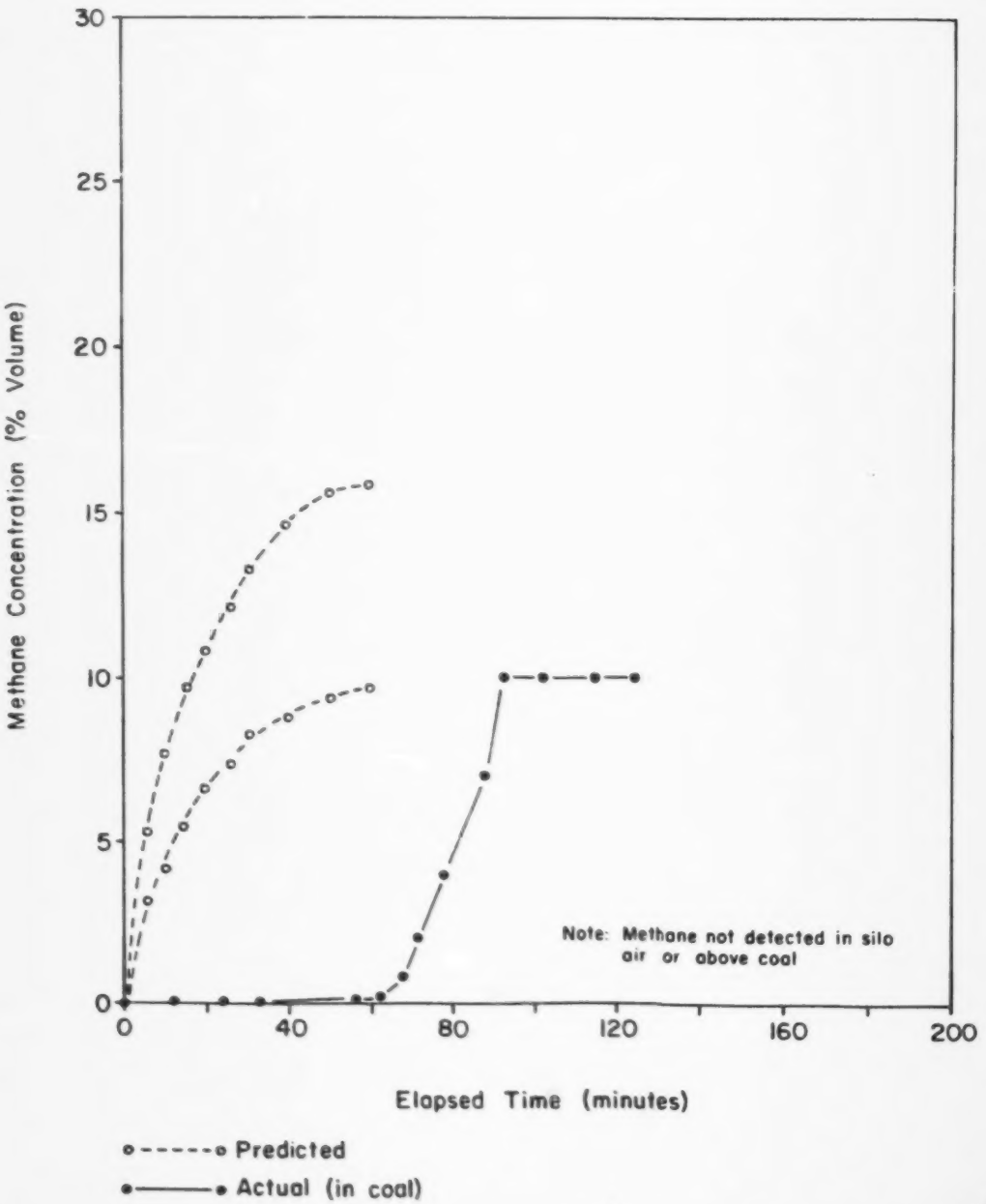

FIGURE C-16
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: H
Sampling Date: August 13, 1985
Coal Temperature 20°C
Coal Product: Raw Metallurgical

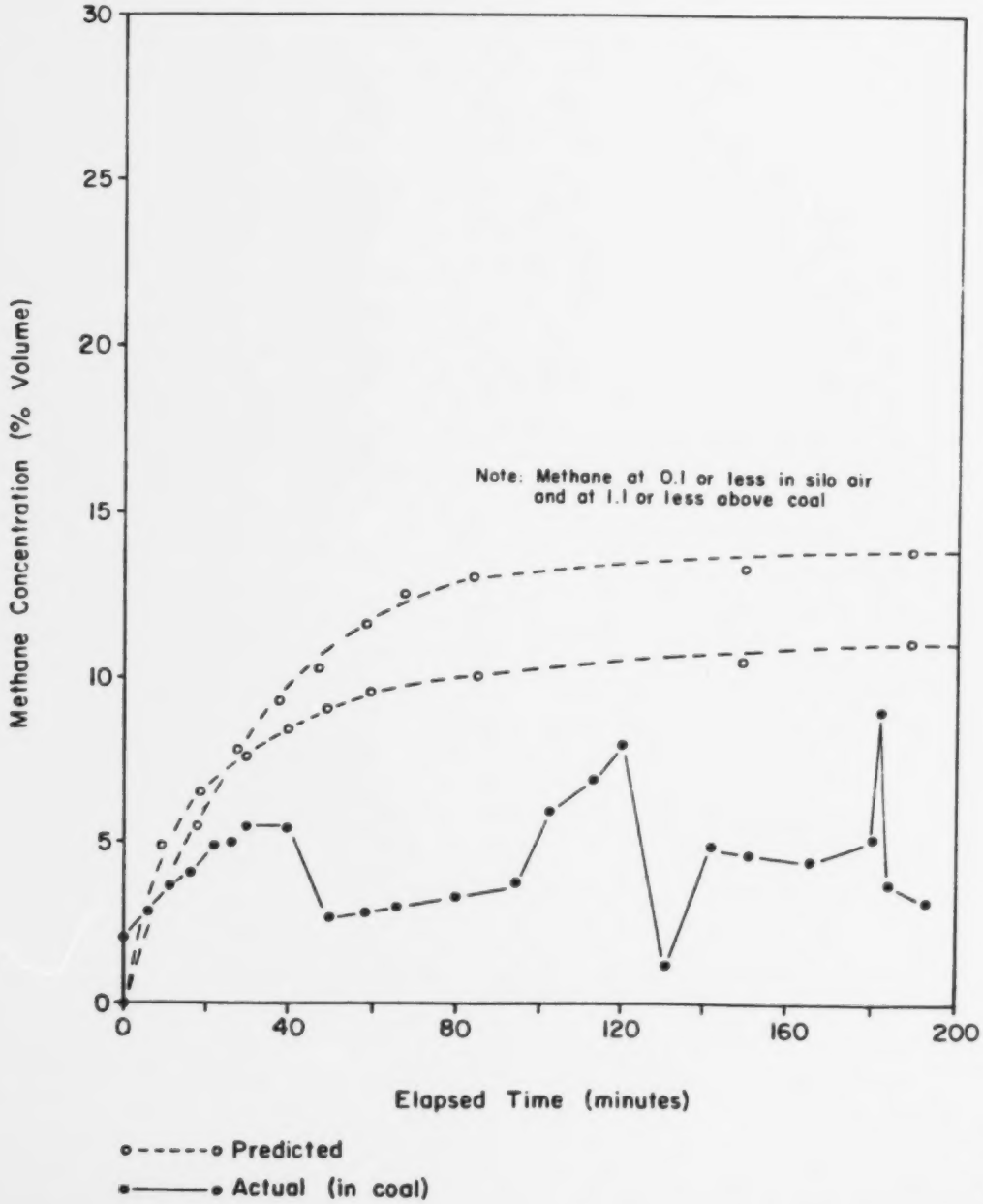

FIGURE C-17
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: H
Sampling Date: August 14/18, 1985
Coal Temperature 32°/37°C
Coal Product: Clean

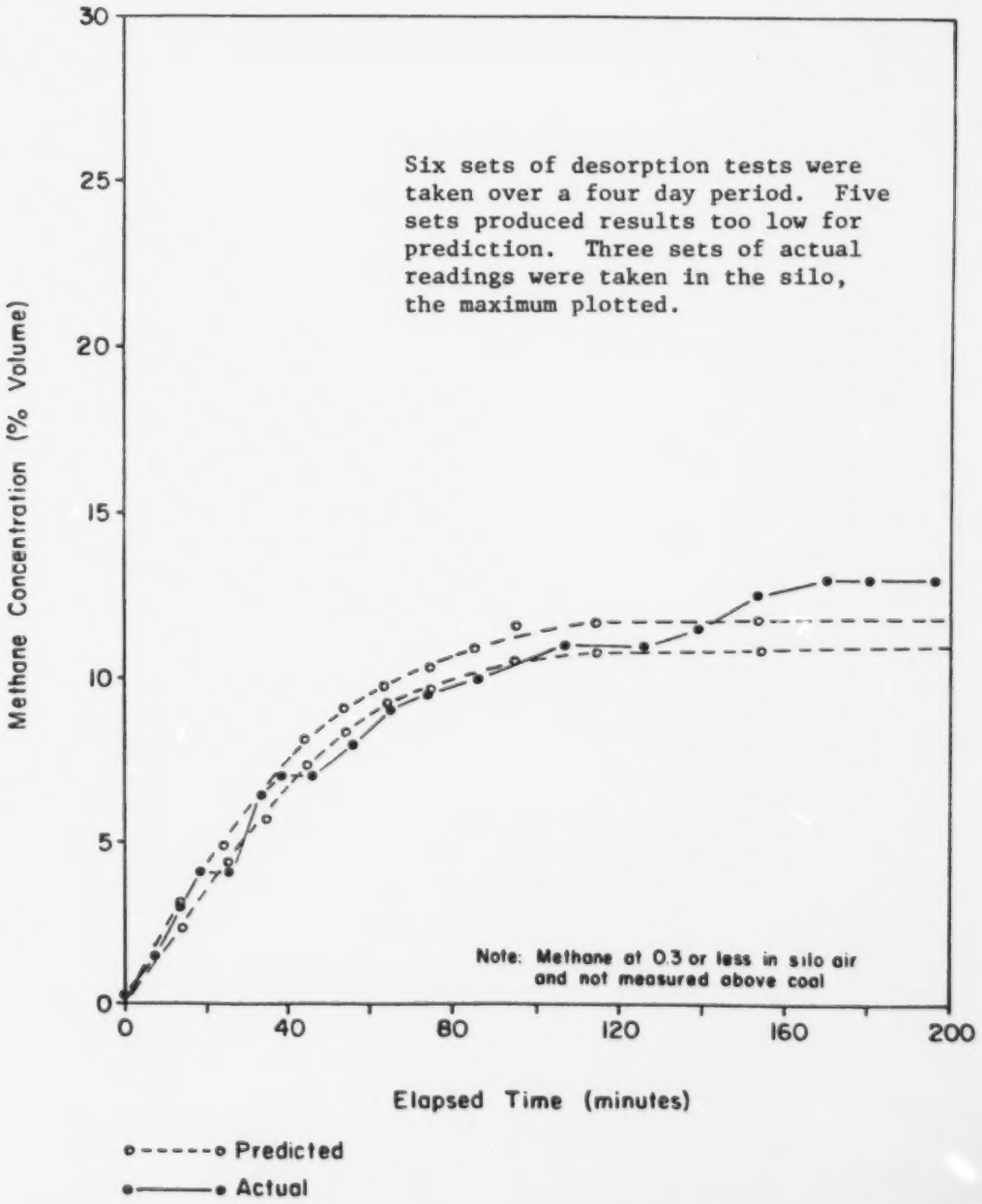

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FIGURE C-18

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: I
Sampling Date: July 25, 1985
Coal Temperature 18°C
Coal Product: Raw Metallurgical

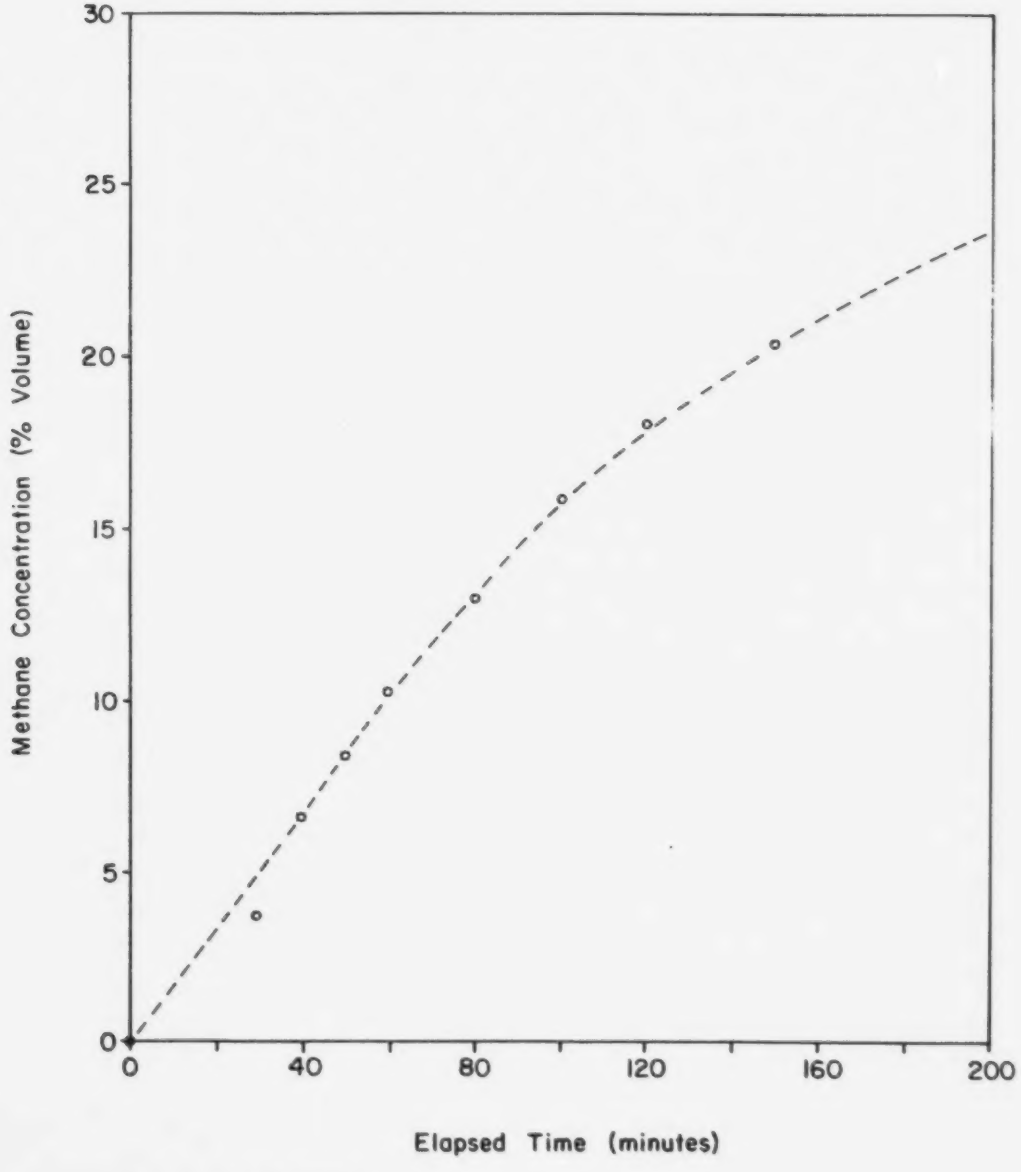

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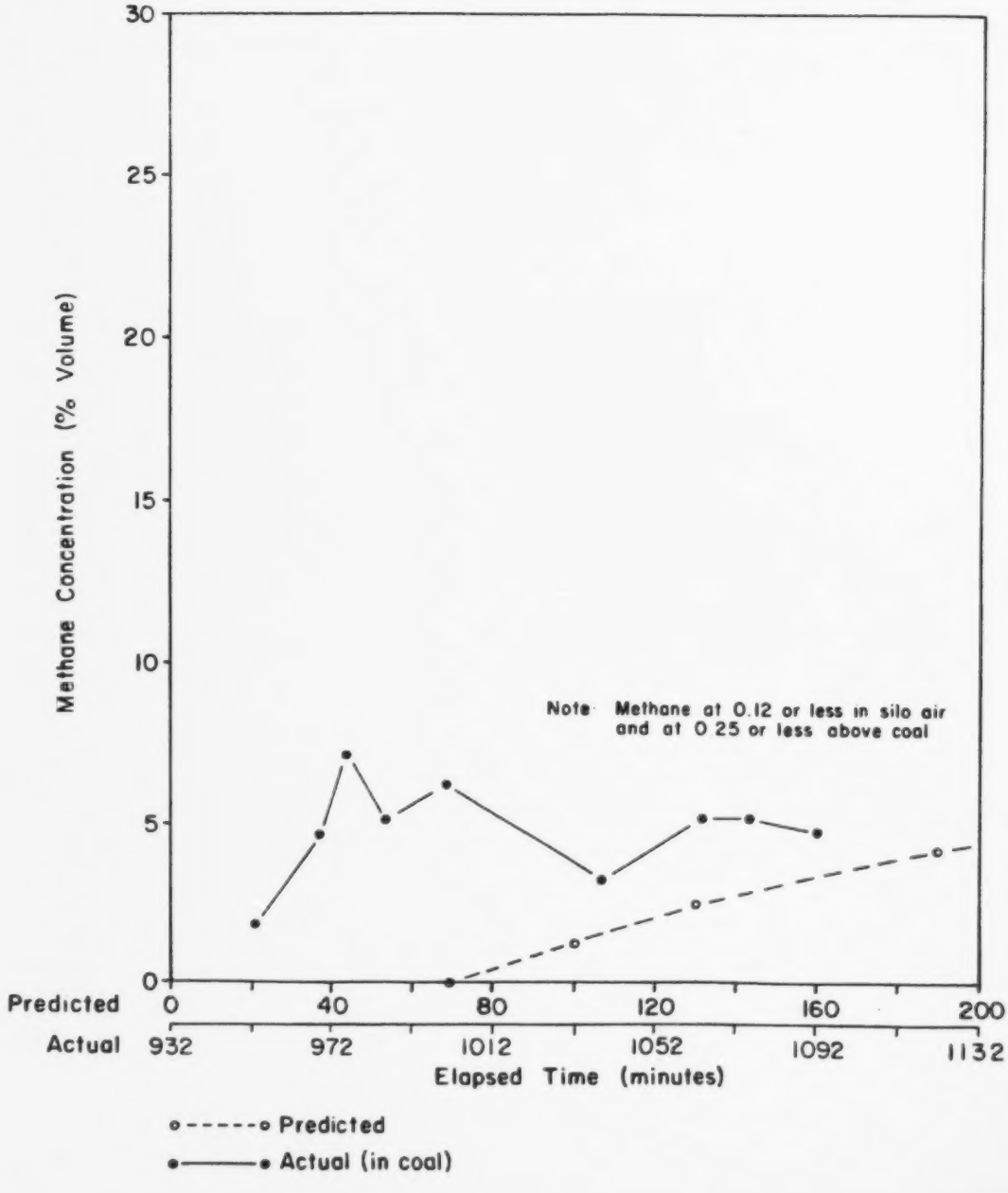
FIGURE C-19
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

SURVEY RESULTS

Mine: I
Sampling Date: July 25/26, 1985
Coal Temperature 27°C
Coal Product: Clean Metallurgical



APPENDIX D

Explosive Mixtures - Coward Triangle

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FIGURE D-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: A
Sampling Date: August 14, 1985
Coal Temperature: 28°C
Coal Product: Raw Metallurgical

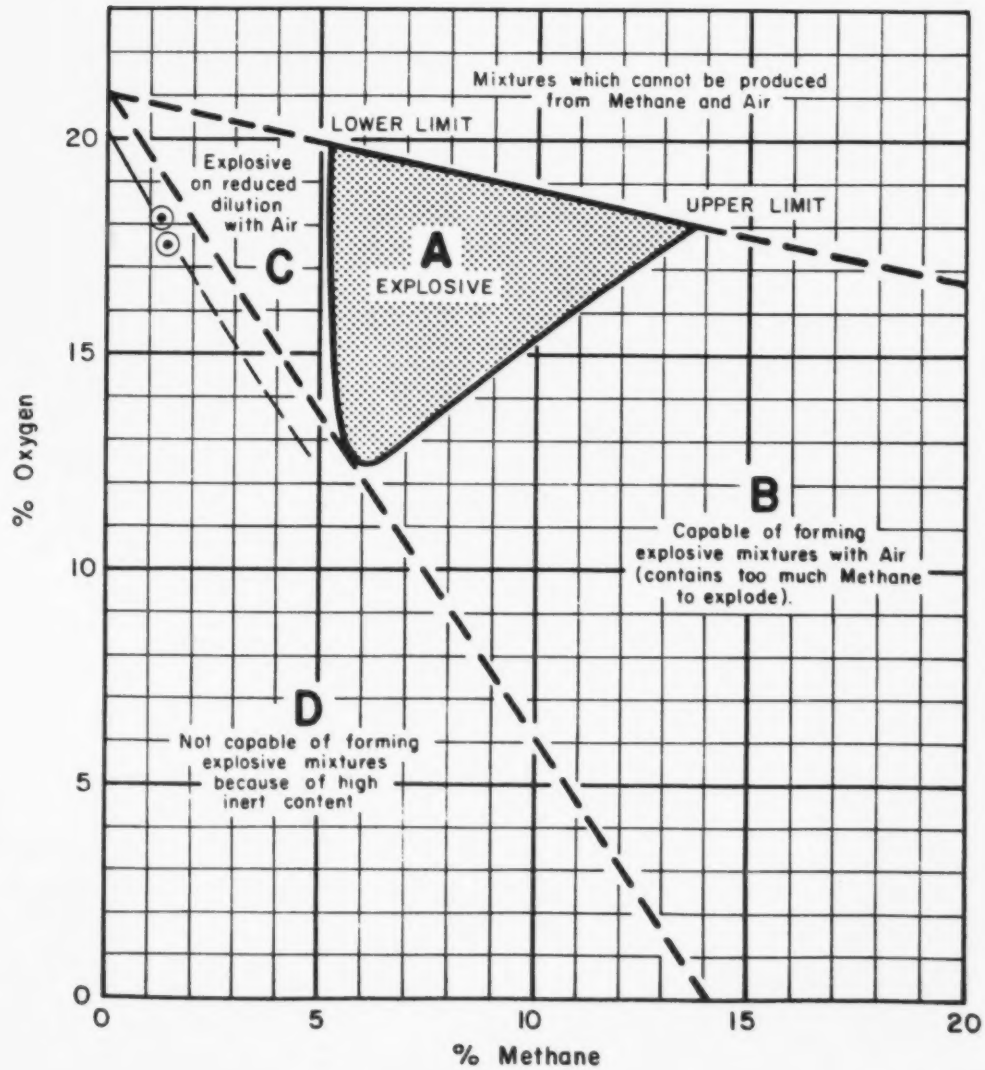

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FIGURE D-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical (Truck Loadout)

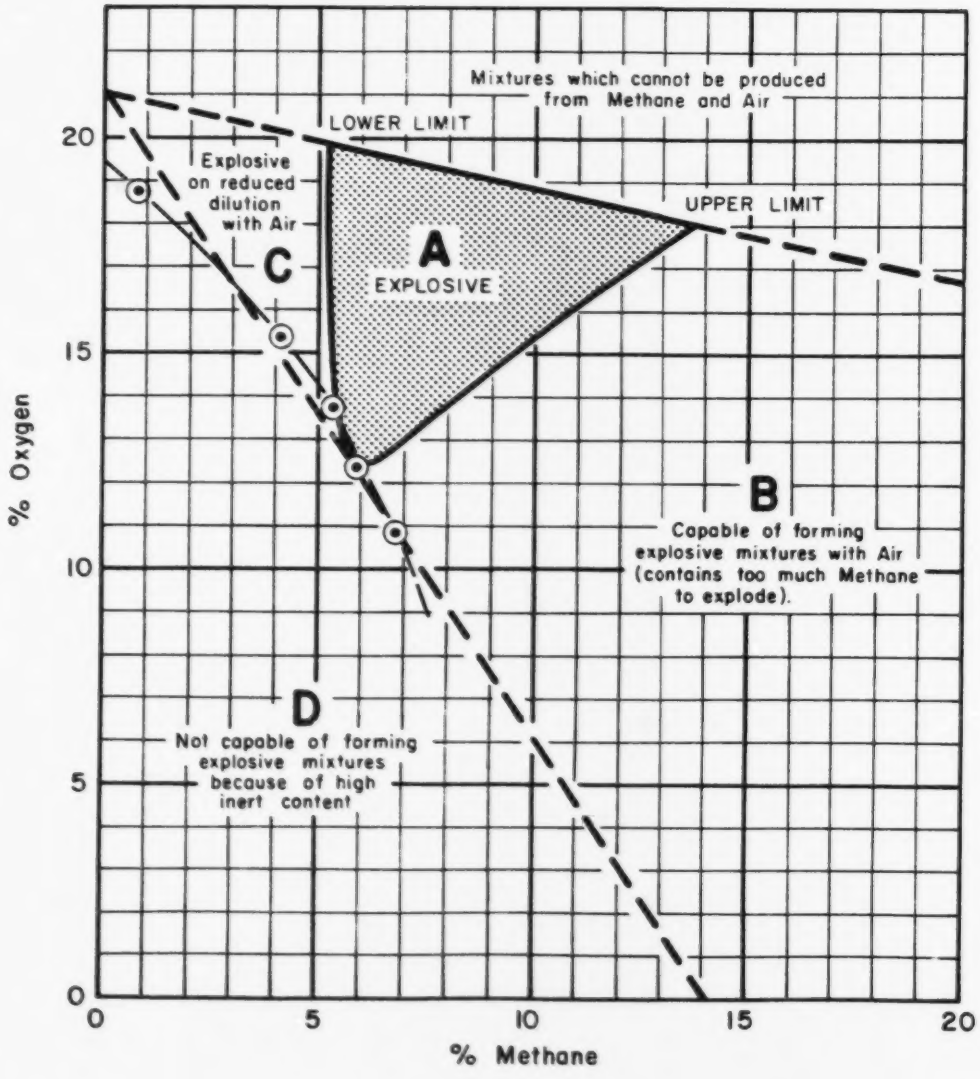

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FIGURE D-3
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical (Rail Loadout)

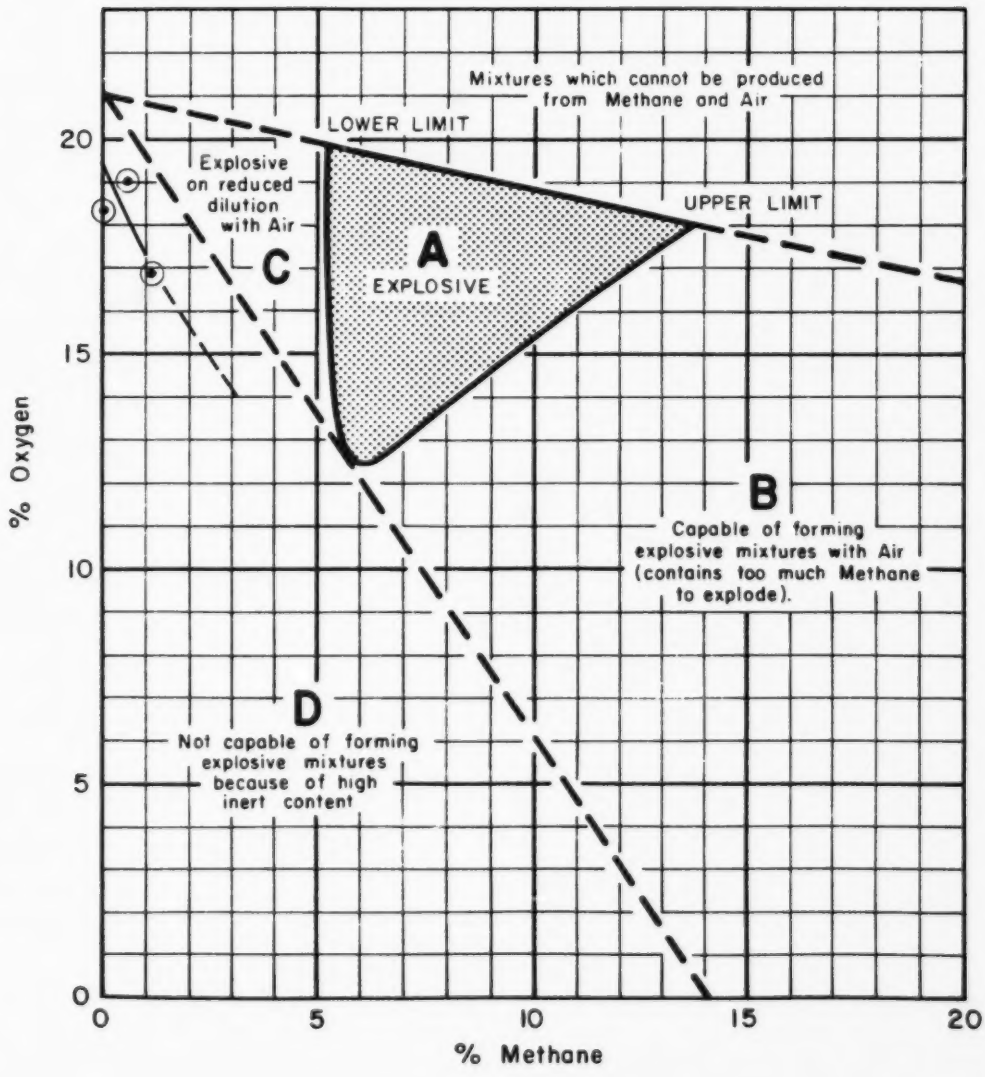

FIGURE D-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: C
Sampling Date: June 12/13, 1985
Coal Temperature: 35°C
Coal Product: Clean Metallurgical

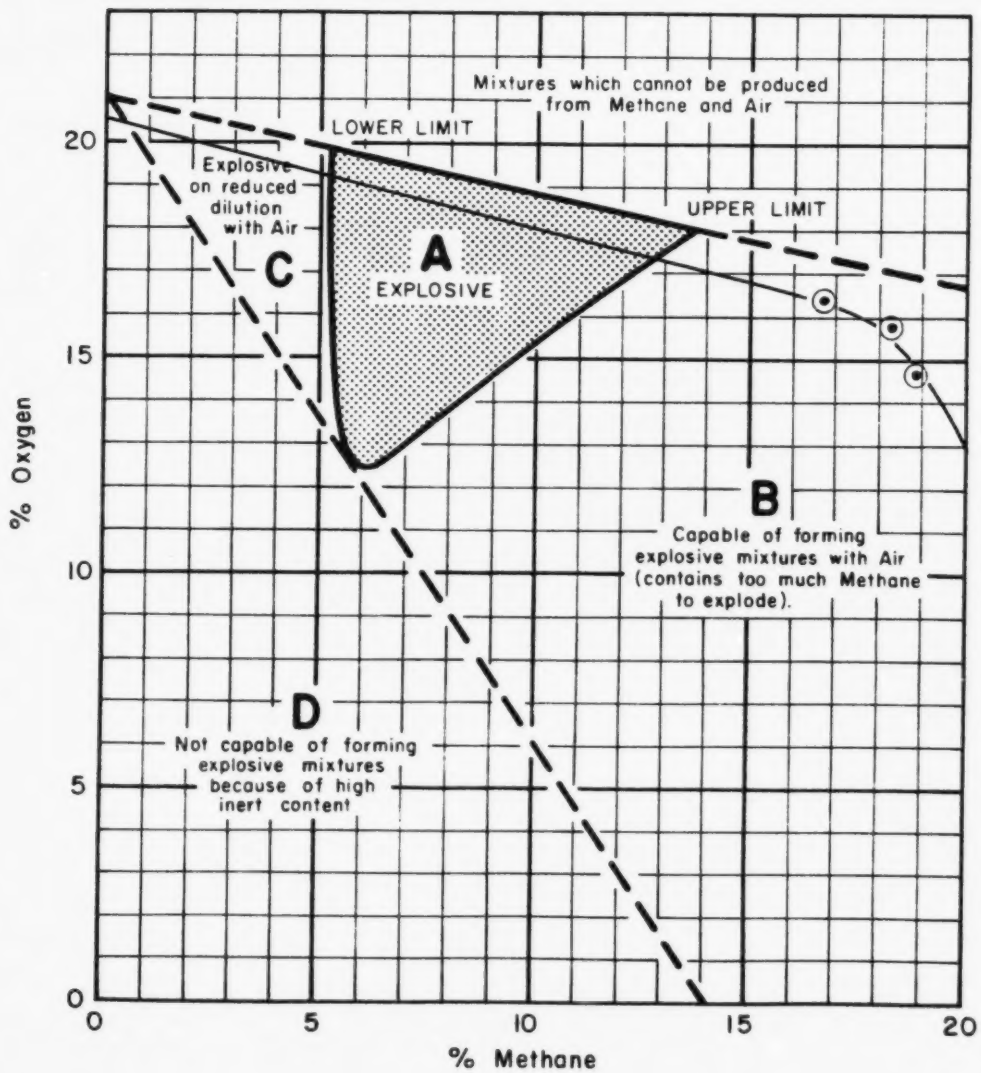

FIGURE D-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: C
Sampling Date: September 10, 1985
Coal Temperature: 38°C
Coal Product: Clean Metallurgical

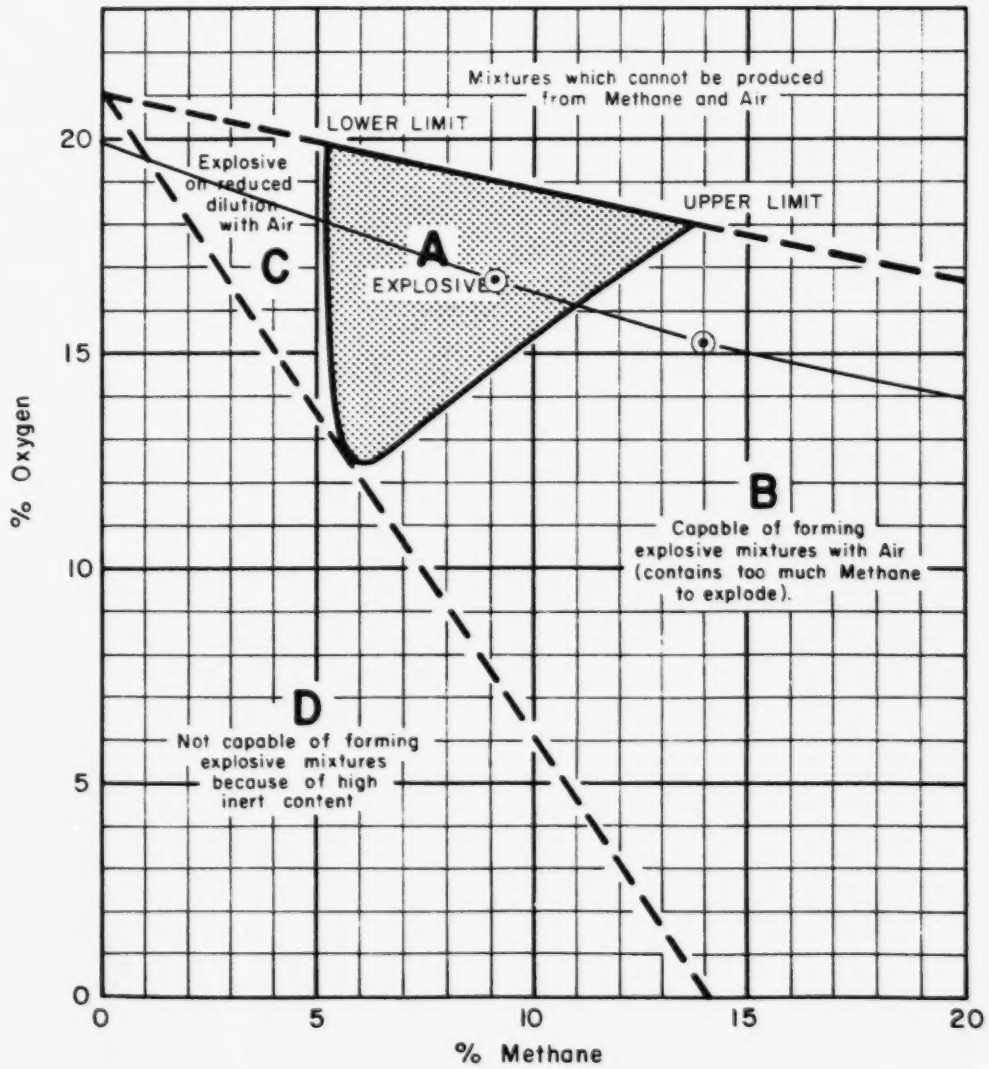

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FIGURE D-6
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: D
Sampling Date: May 22/23, 1985
Coal Temperature: 40°C
Coal Product: Clean Thermal

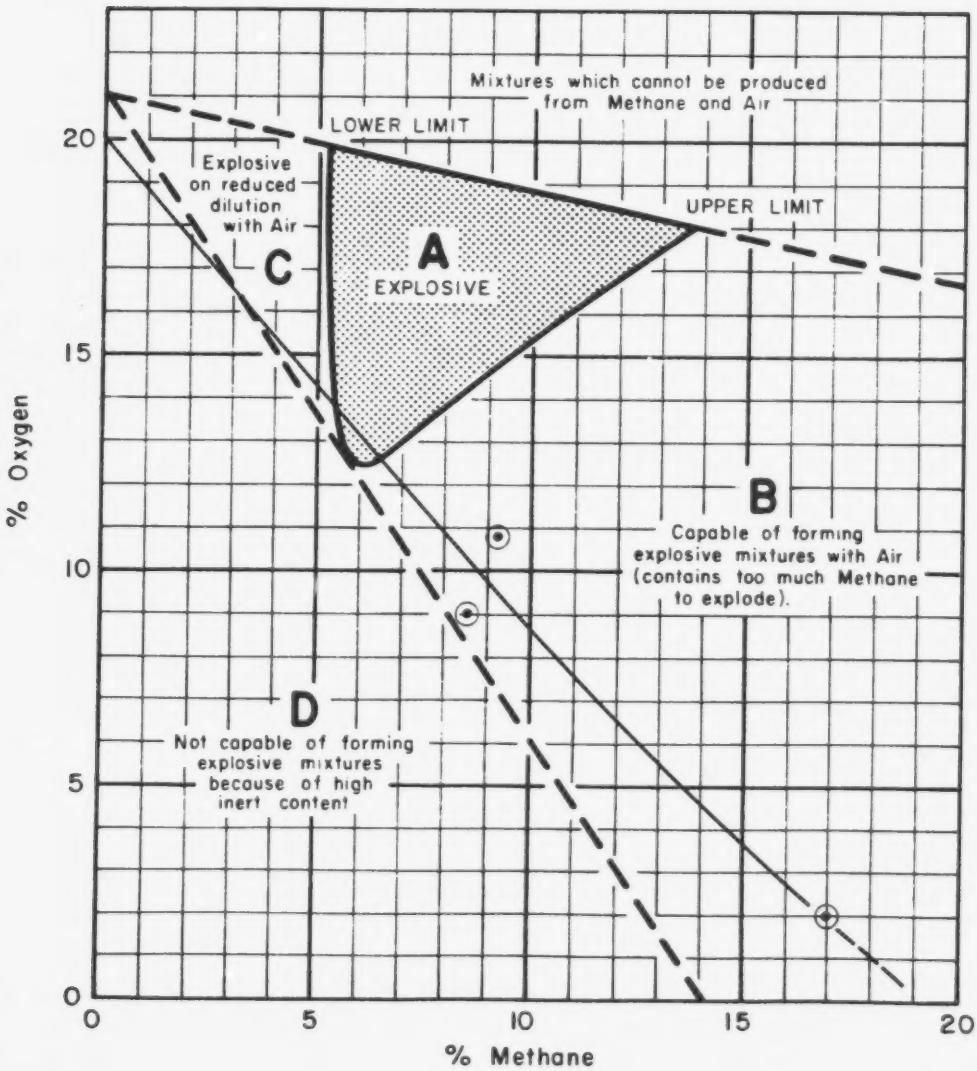

FIGURE D-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: E
Sampling Date: July 18, 1985
Coal Temperature: 45°C
Coal Product: Clean Metallurgical

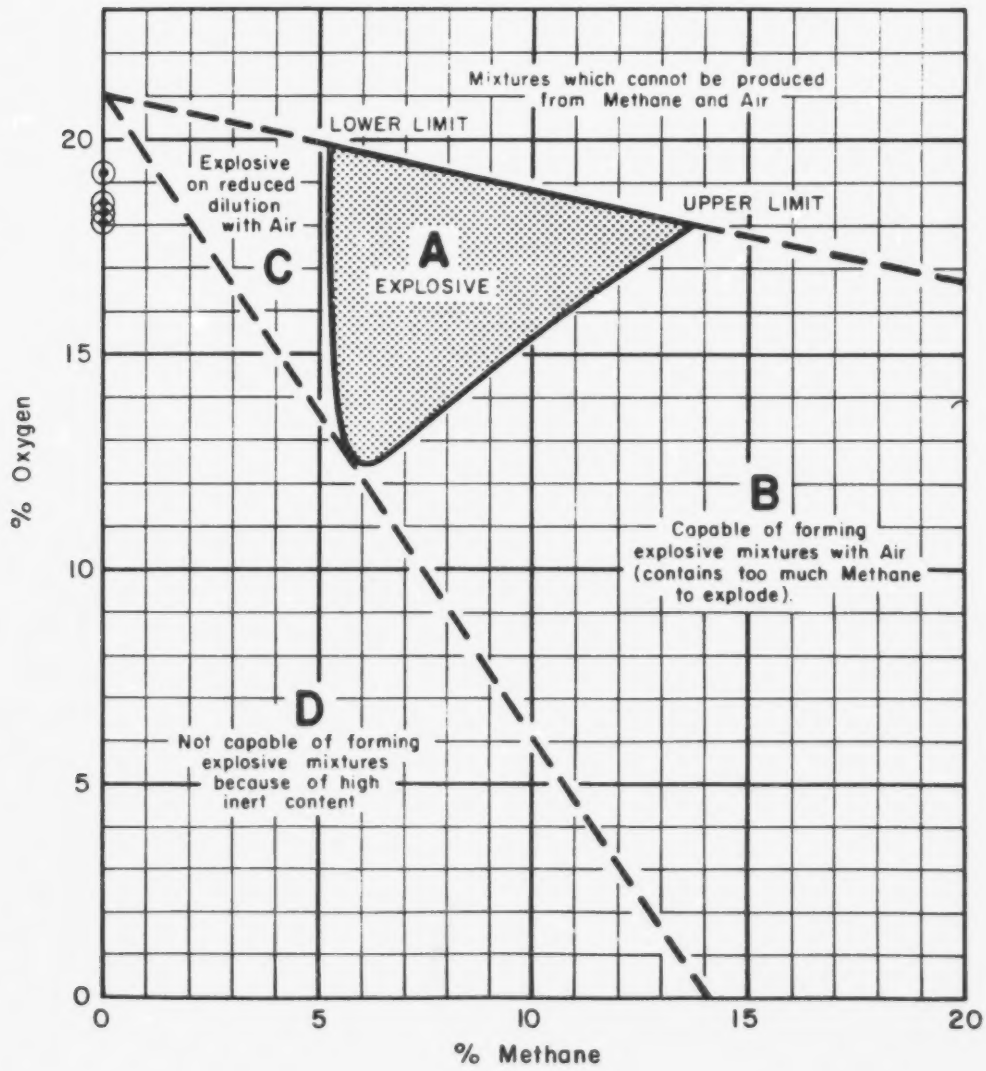

FIGURE D-8
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: F
Sampling Date: June 10/11, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

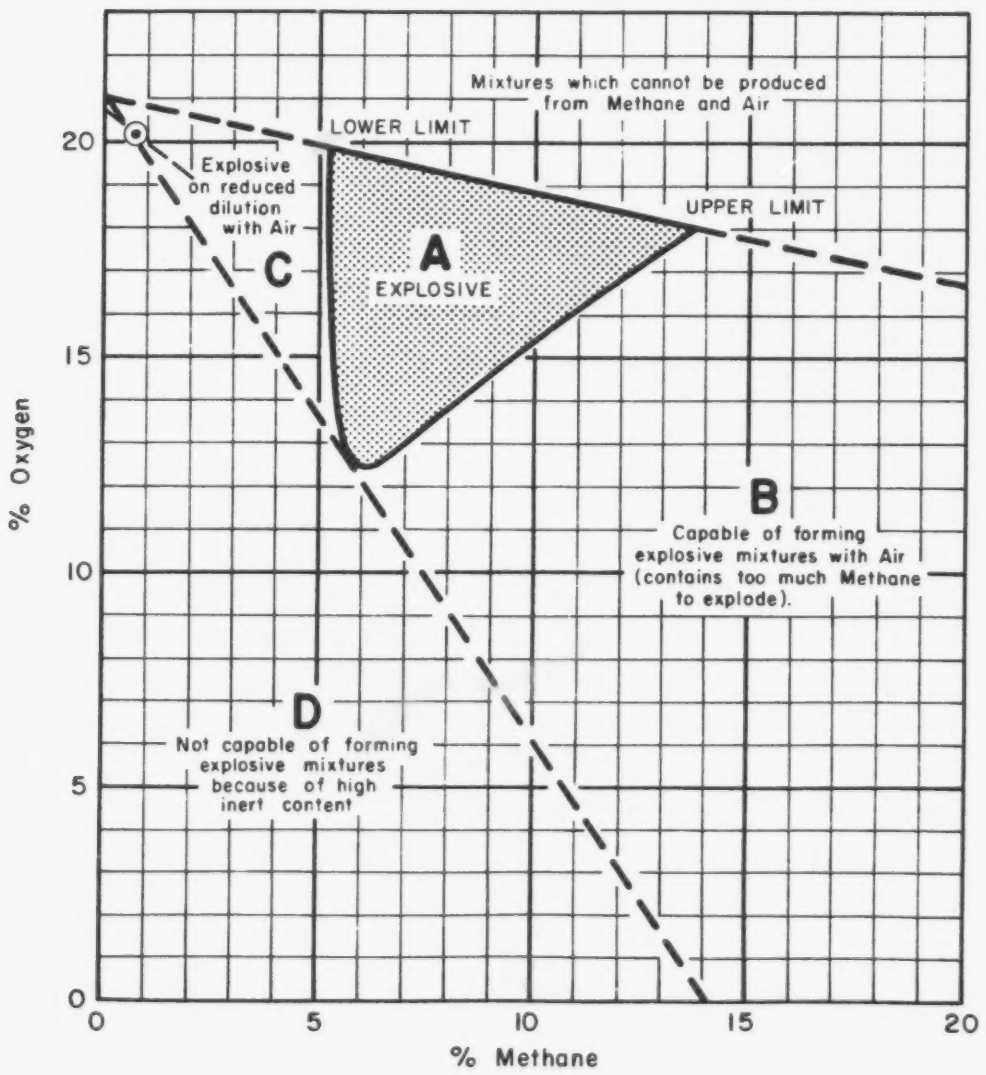

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FIGURE D-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: F
Sampling Date: September 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

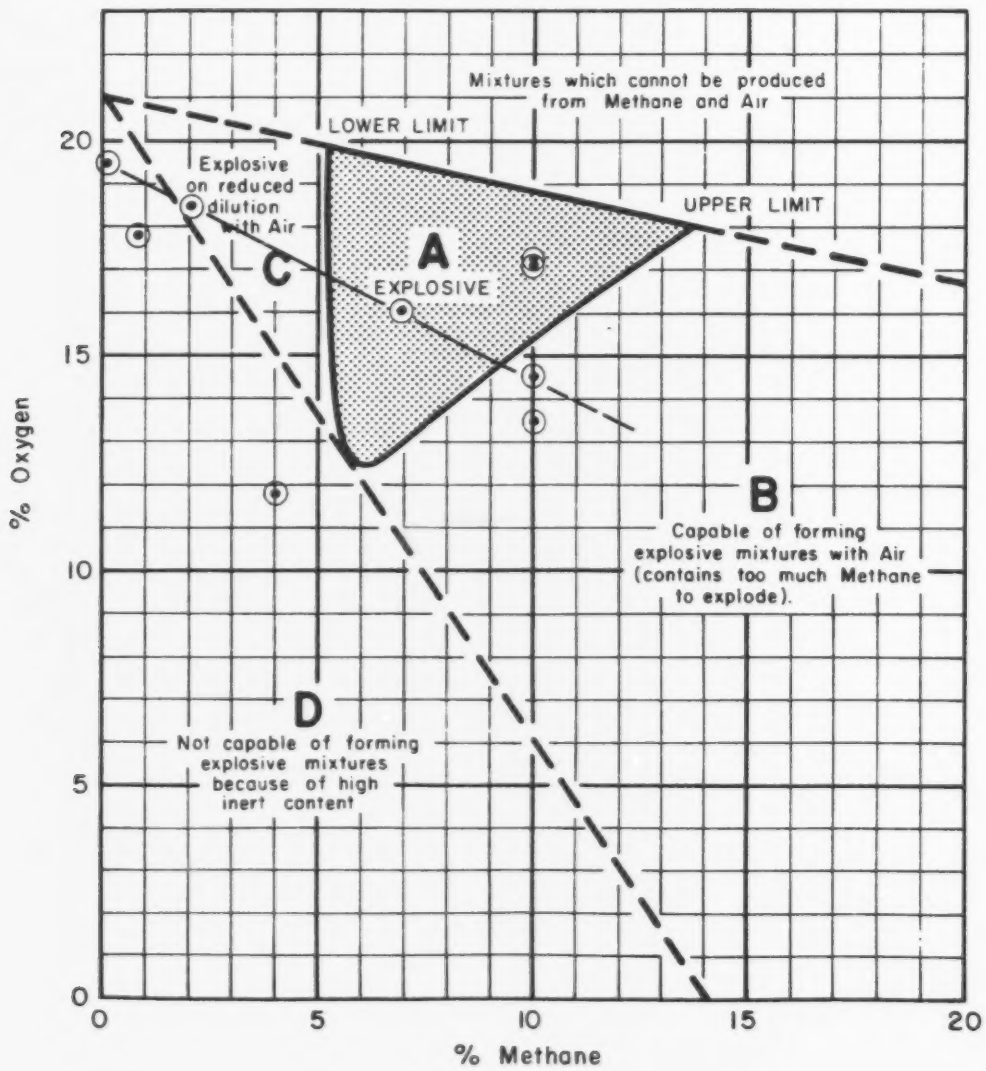

FIGURE D-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: H
Sampling Date: August 13, 1985
Coal Temperature: 20°C
Coal Product: Raw Metallurgical

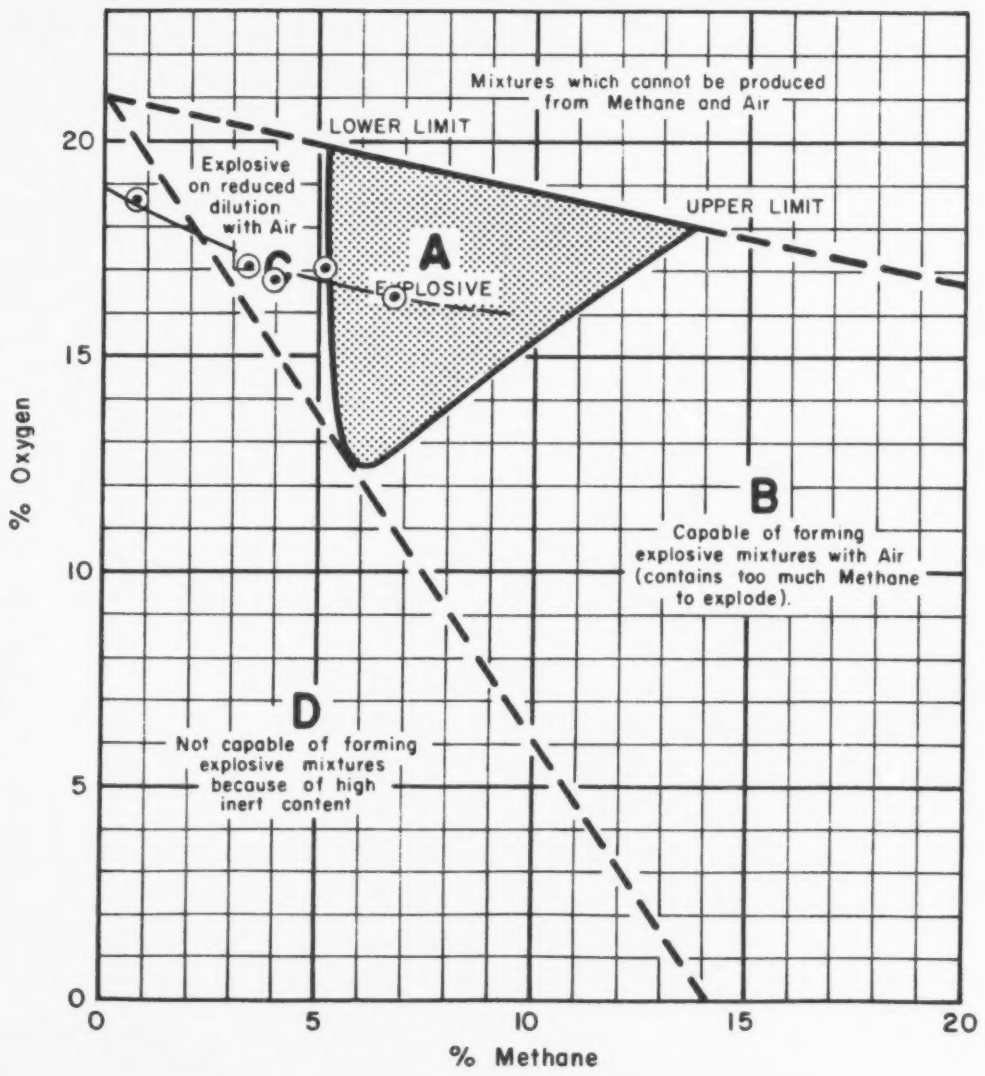

FIGURE D-11
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: H
Sampling Date: August 14, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical

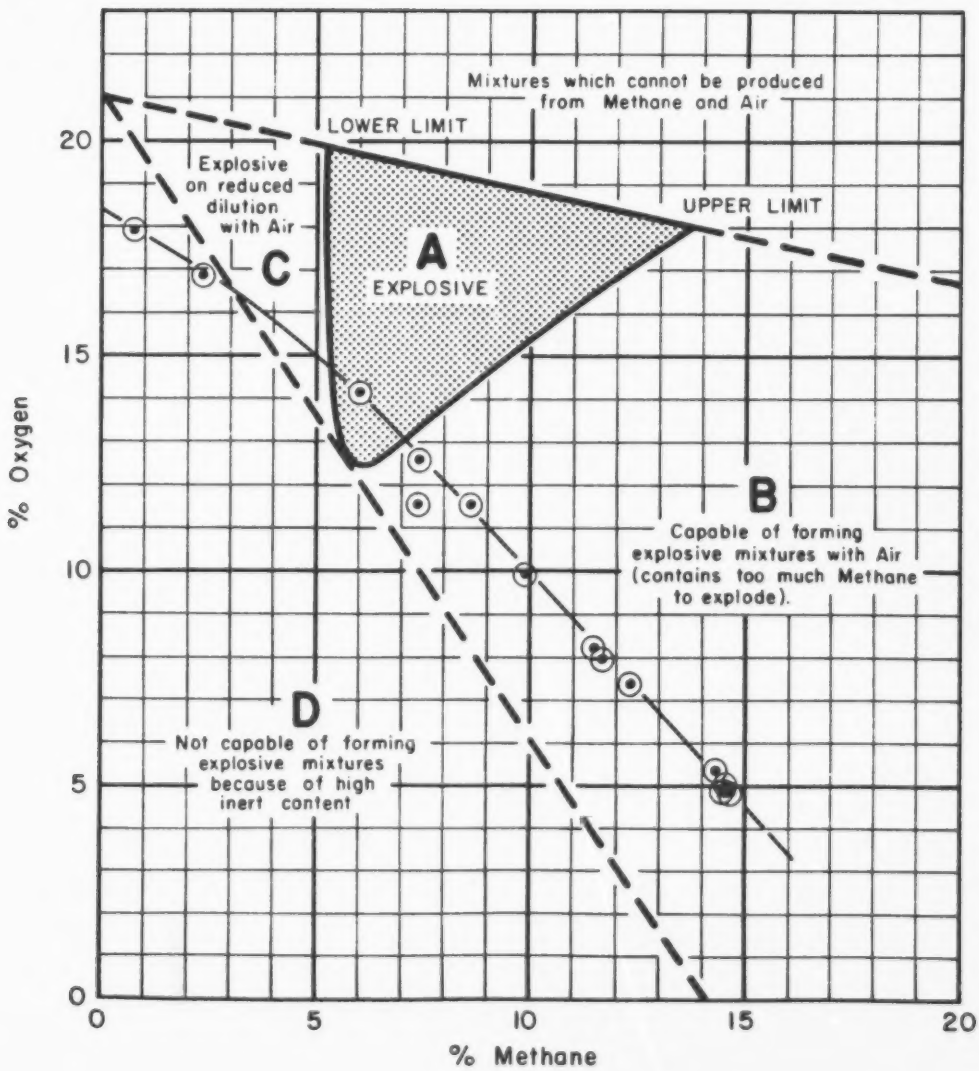

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FIGURE D-12
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: H
Sampling Date: August 17, 1985
Coal Temperature: 37°C
Coal Product: Clean Metallurgical

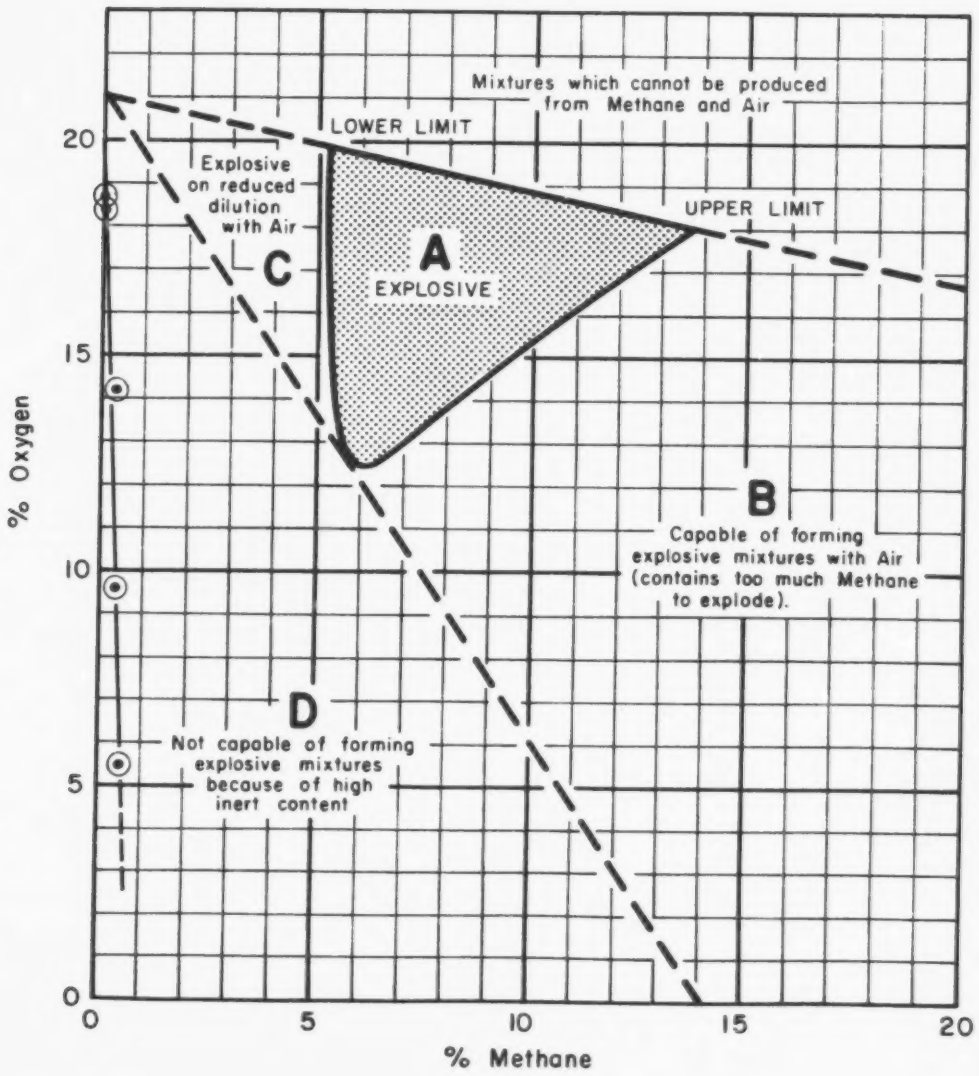

FIGURE D-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: H
Sampling Date: August 18, 1985
Coal Temperature: 37°C
Coal Product: Clean Metallurgical

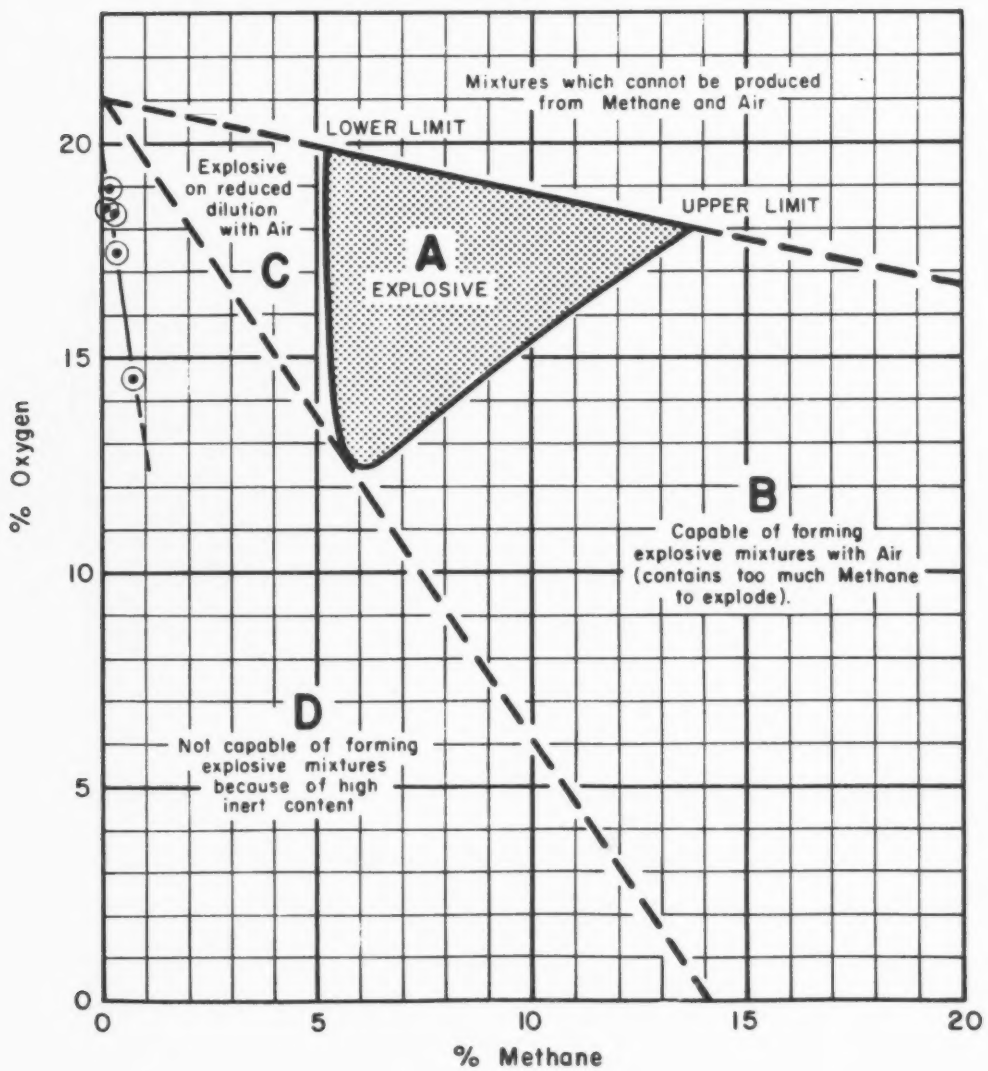

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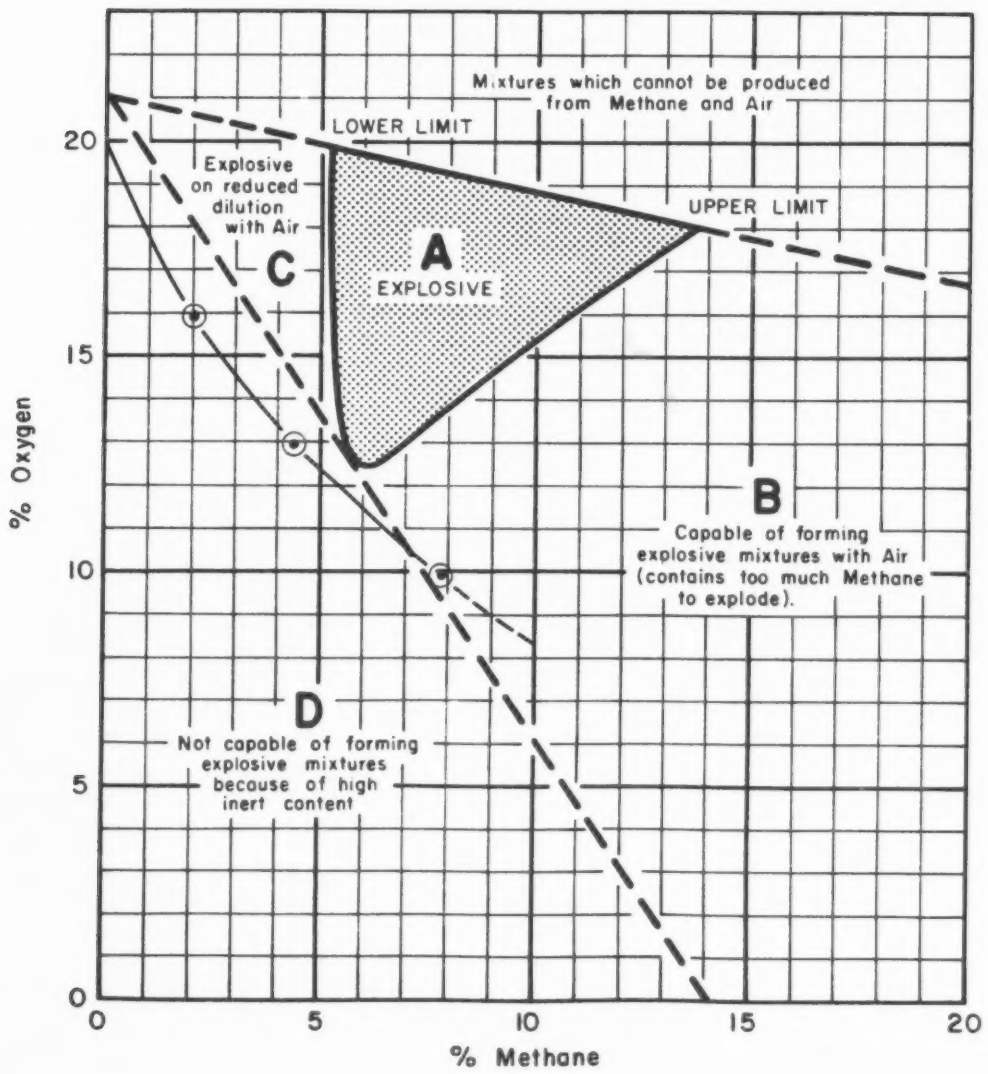
FIGURE D-14
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

EXPLOSIVE MIXTURES - COWARD TRIANGLE

Mine: I
Sampling Date: July 25/26, 1985
Coal Temperature: 27°C
Coal Product: Clean Metallurgical



APPENDIX E

Rate of Desorption

FIGURE E-1
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: A
Sampling Date: August 15, 1985
Coal Temperature: 28°C
Coal Product: Raw Metallurgical

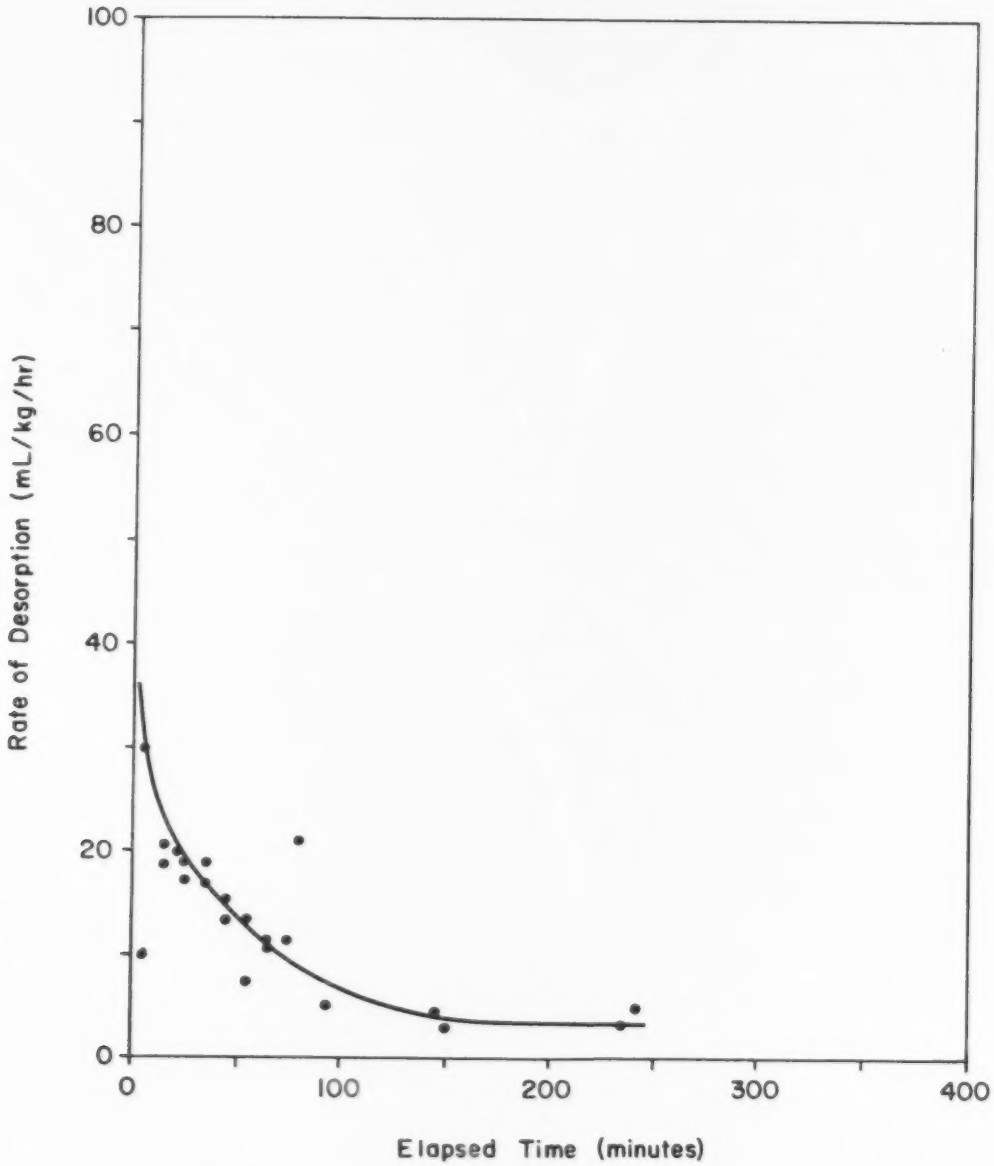


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FIGURE E-2
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 46°C
Coal Product: Clean Metallurgical (Truck Loadout)

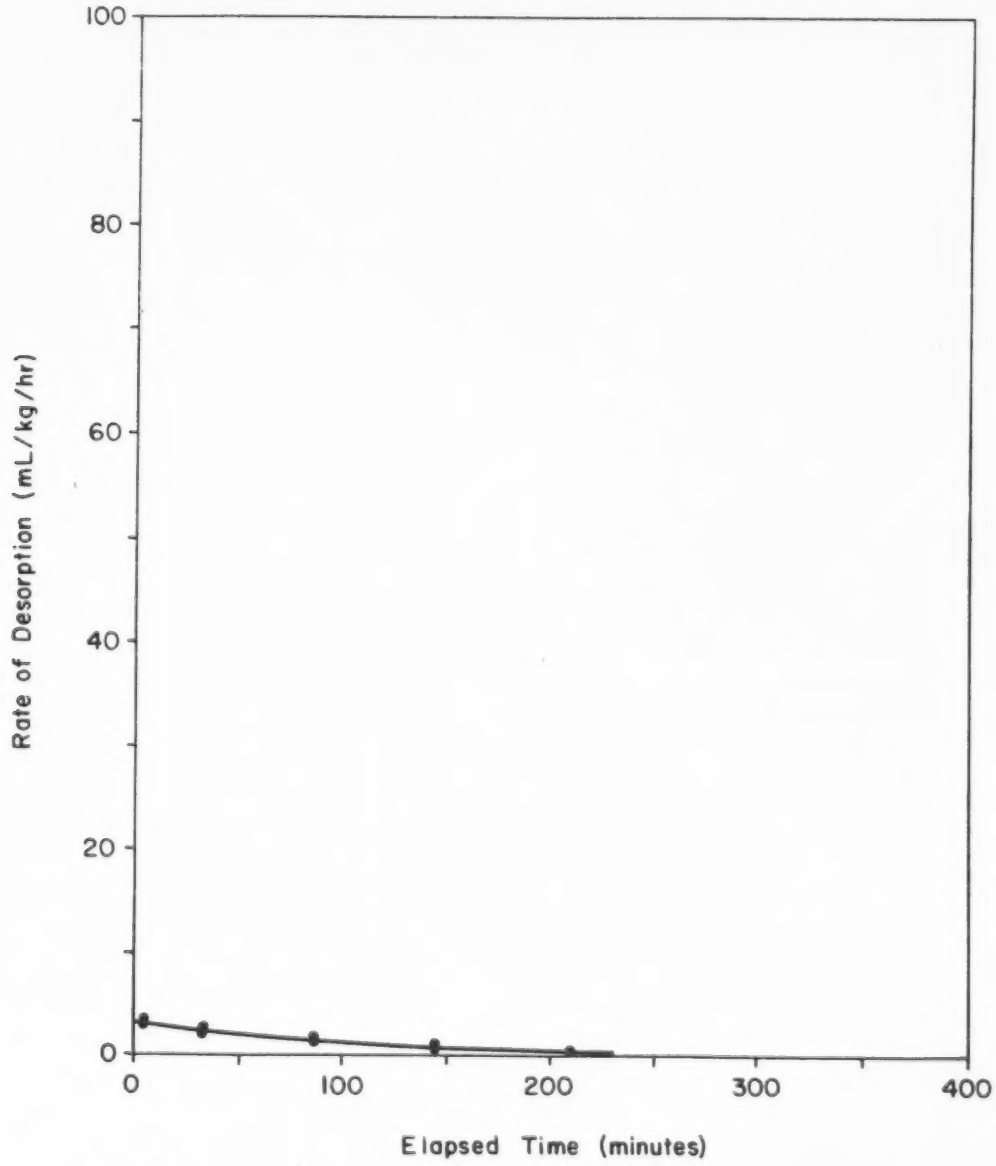

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FIGURE E-3

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: A
Sampling Date: August 16, 1985
Coal Temperature: 32°C
Coal Product: Clean Metallurgical (Rail Loadout)

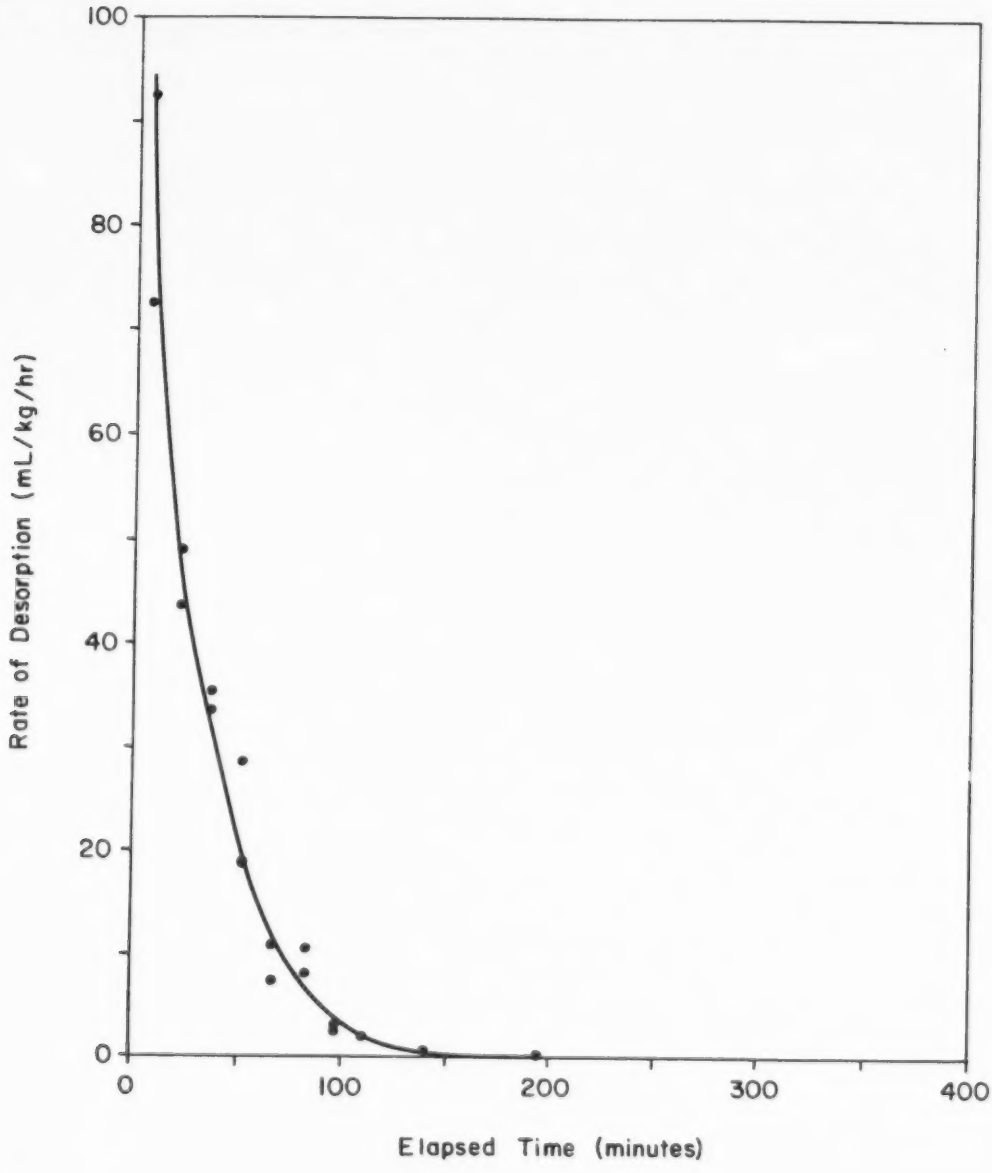

FIGURE E-4
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: B
Sampling Date: July 18, 1985
Coal Temperature: 25°C
Coal Type: Raw

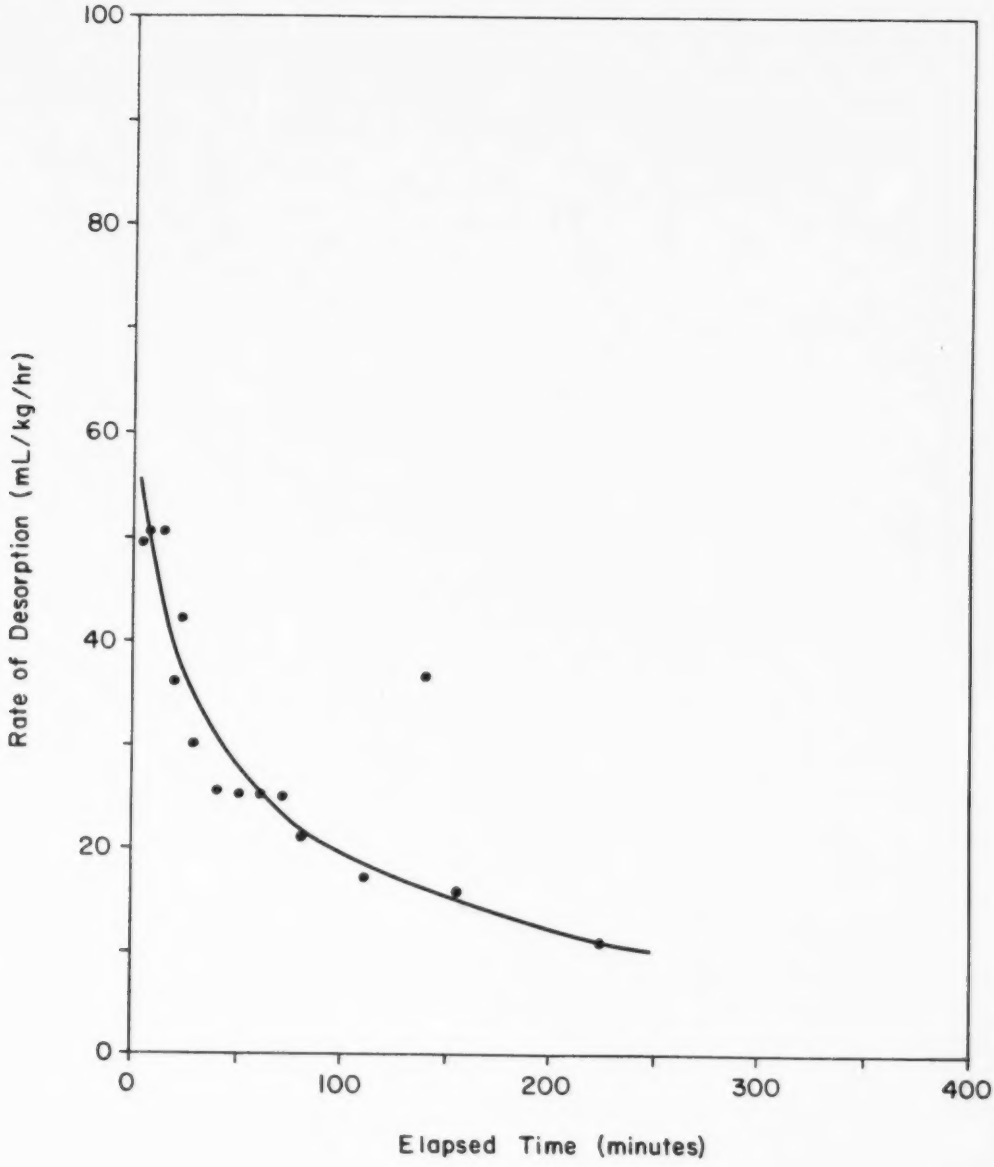

FIGURE E-5
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: B
Sampling Date: July 18, 1985
Coal Temperature: 25°C
Coal Product: Clean

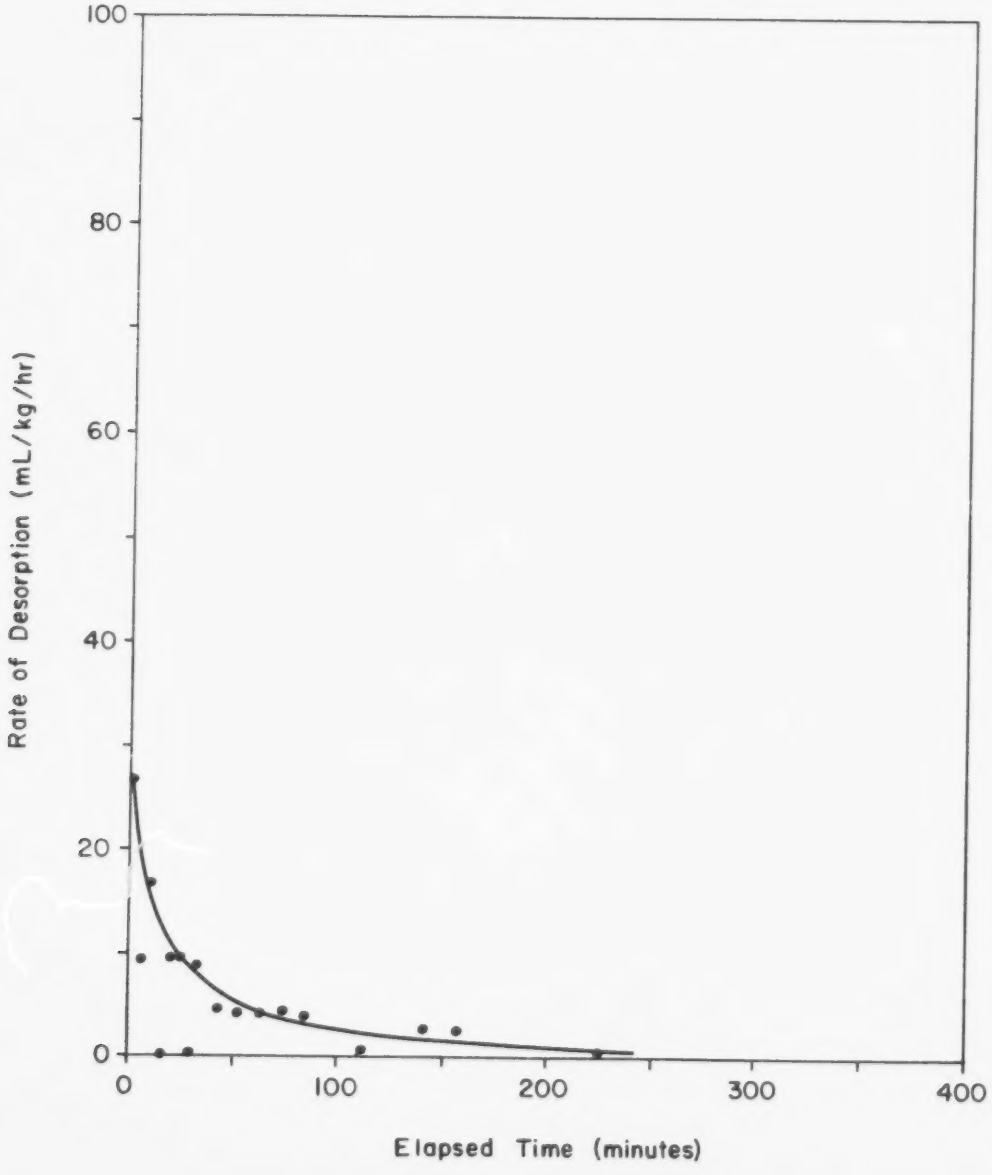

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FIGURE E-6
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: C
Sampling Date: June 13, 1985
Coal Temperature: 18°C
Coal Product: Raw Metallurgical

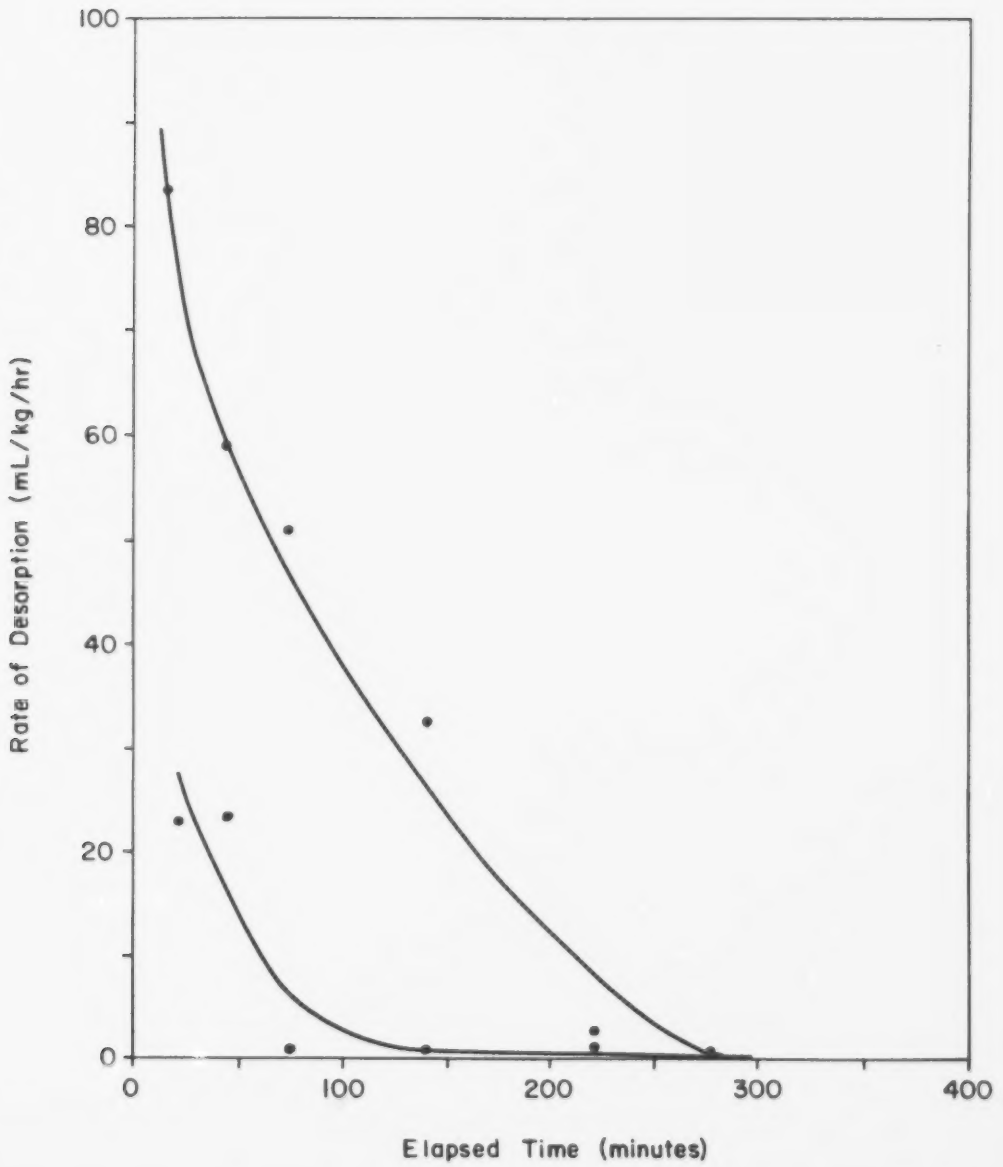

FIGURE E-7
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: C
Sampling Date: June 13, 1985
Coal Temperature: 35°C
Coal Product: Clean Metallurgical

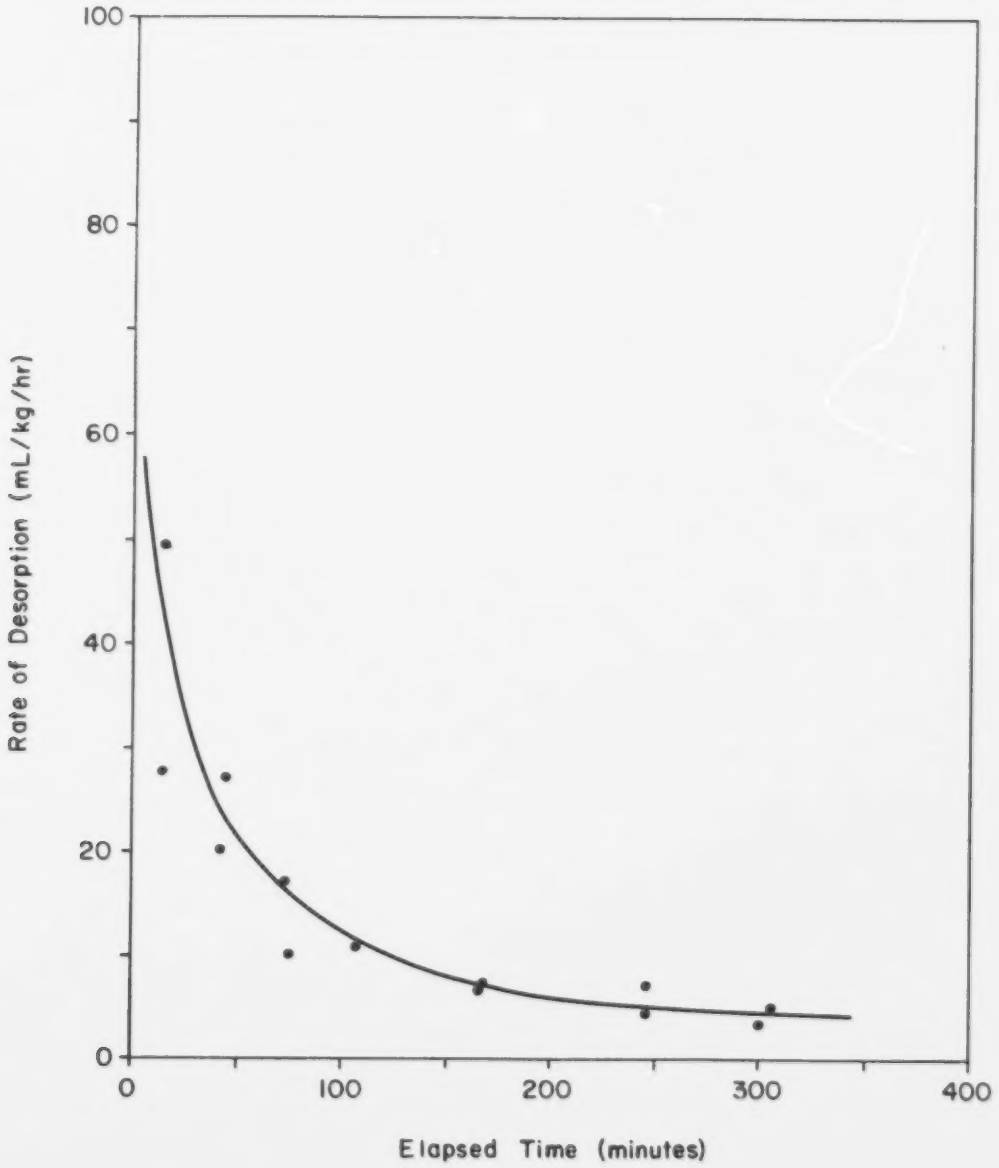

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FIGURE E-8
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: C
Sampling Date: September 10, 1985
Coal Temperature: 38°C
Coal Product: Clean Metallurgical

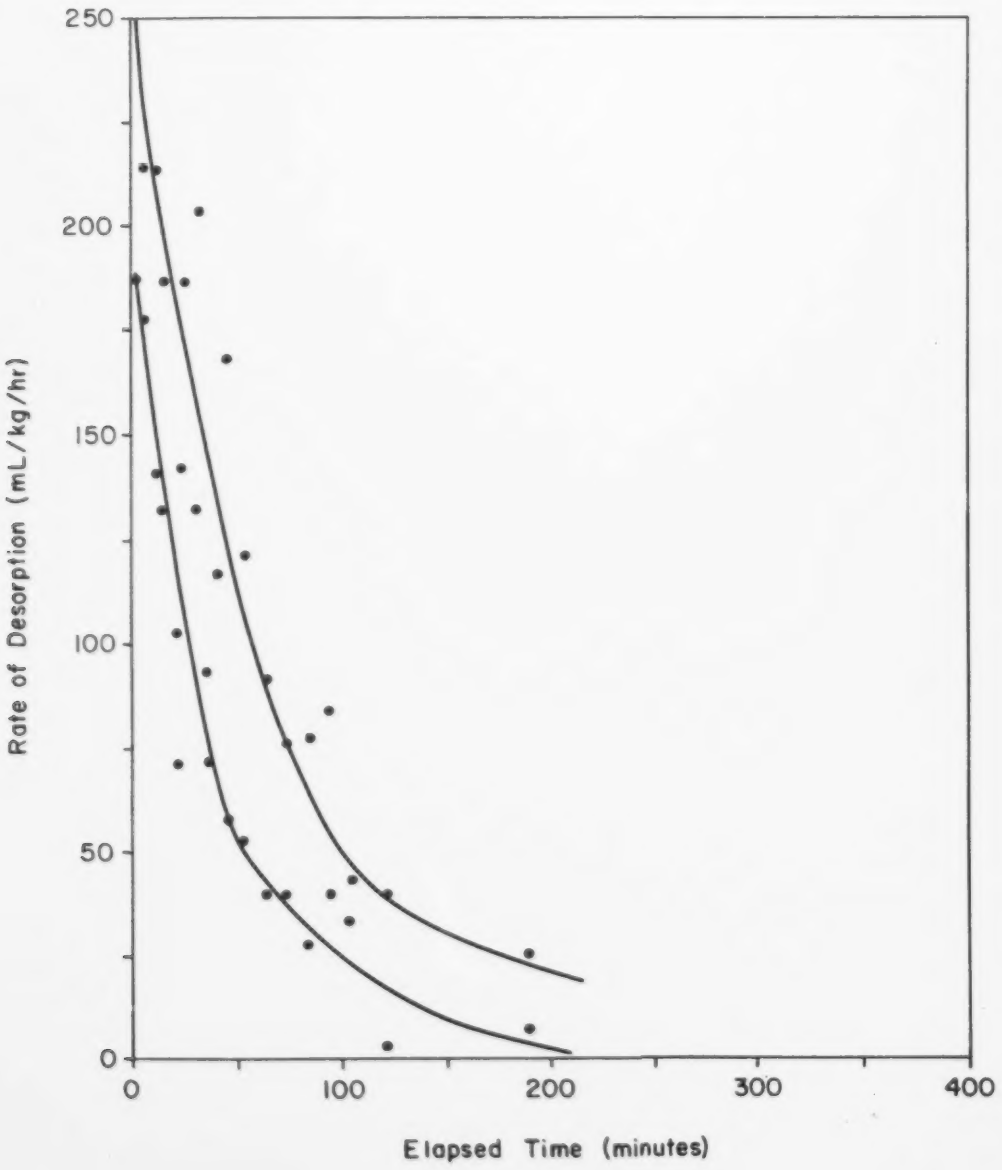
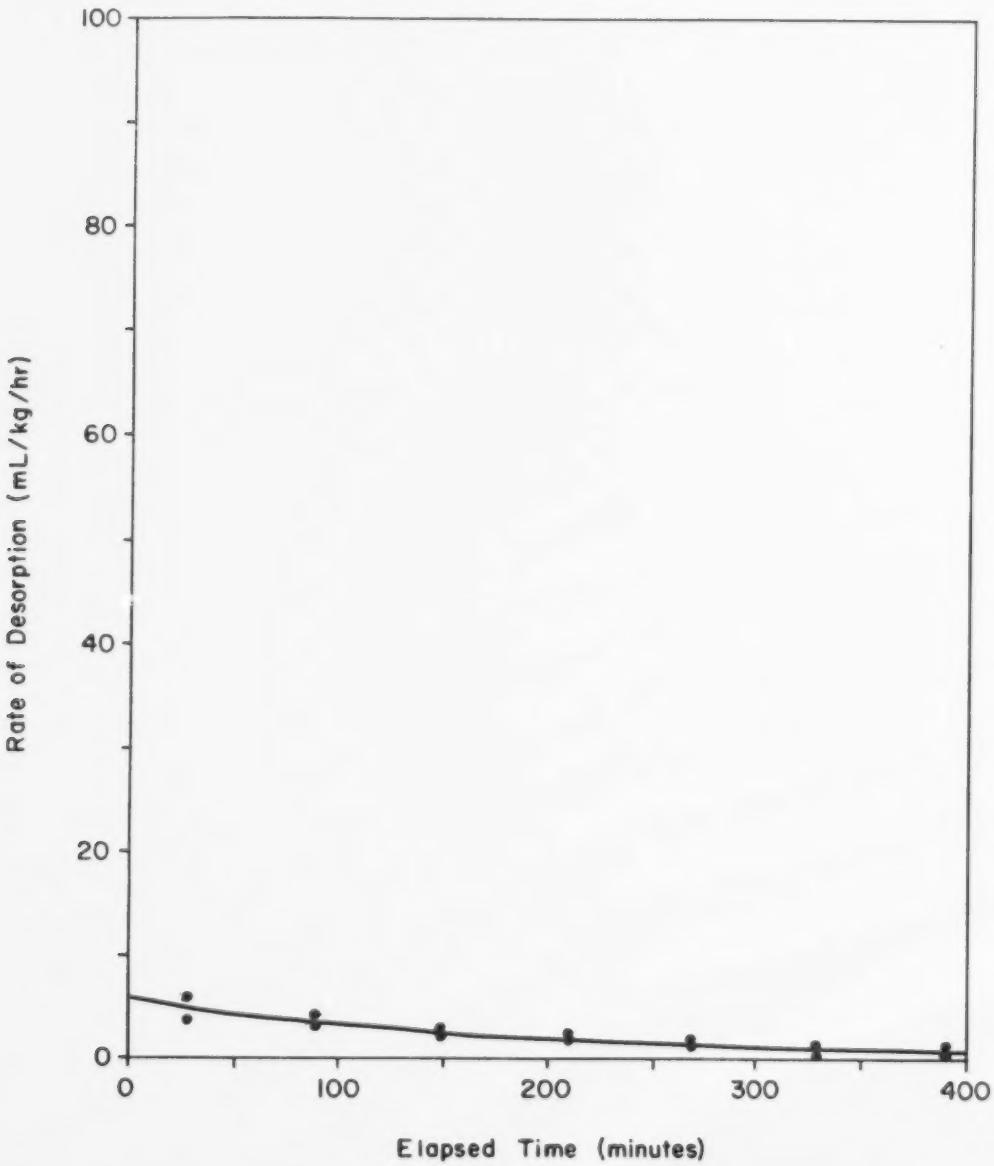


FIGURE E-9
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: D
Sampling Date: May 24, 1985*
Coal Temperature: 40°C
Coal Product: Clean Thermal



* Start of test May 27, 1985 (Sample Sealed 69.5 hrs.)

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FIGURE E-10
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: E
Sampling Date: July 17, 1985
Coal Temperature: 18°C
Coal Product: Raw Metallurgical

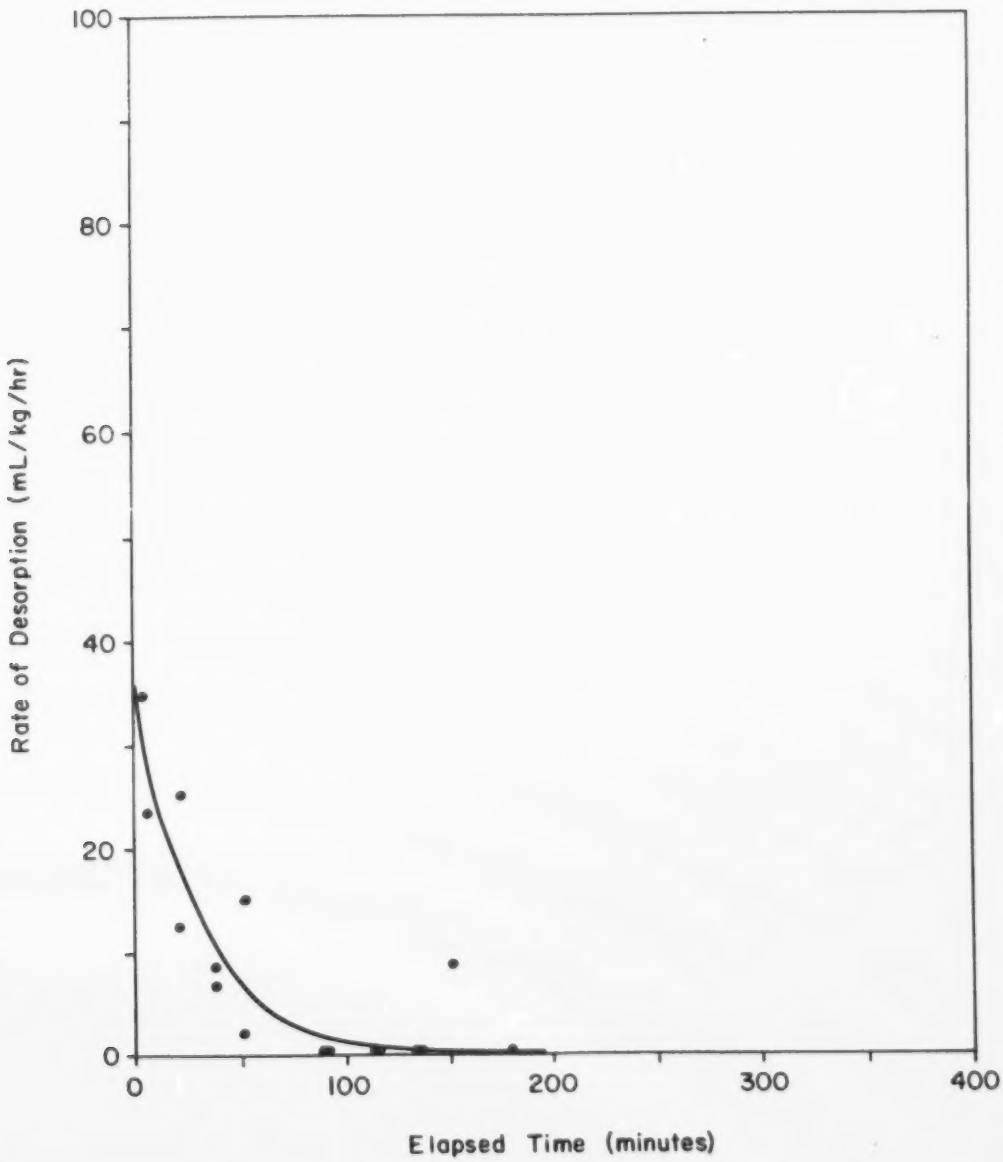

FIGURE E-11
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: E
Sampling Date: July 18, 1985
Coal Temperature: 45°C
Coal Product: Clean Metallurgical

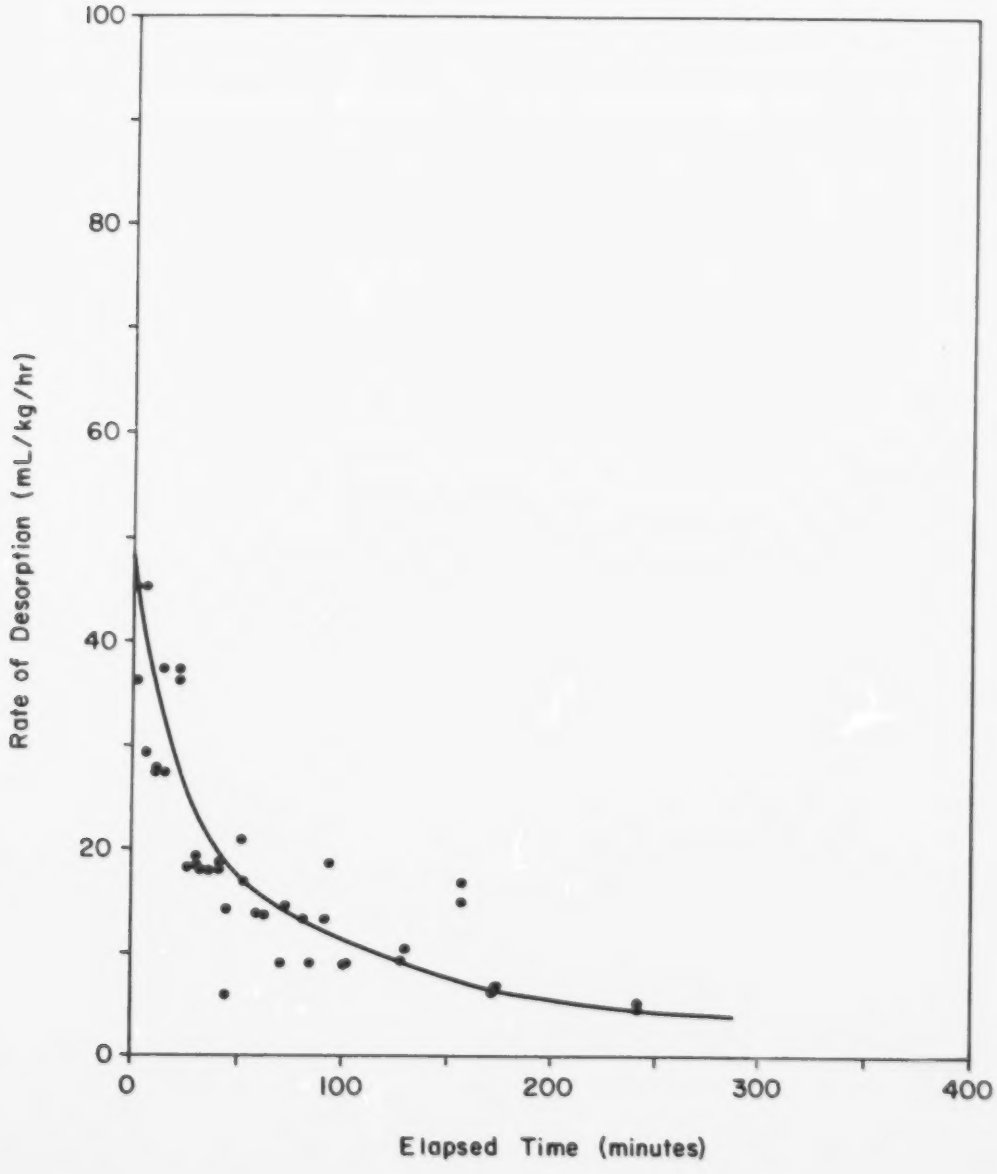

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FIGURE E-12
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: F
Sampling Date: June 12, 1985
Coal Temperature: 18°C
Coal Product: Raw Metallurgical

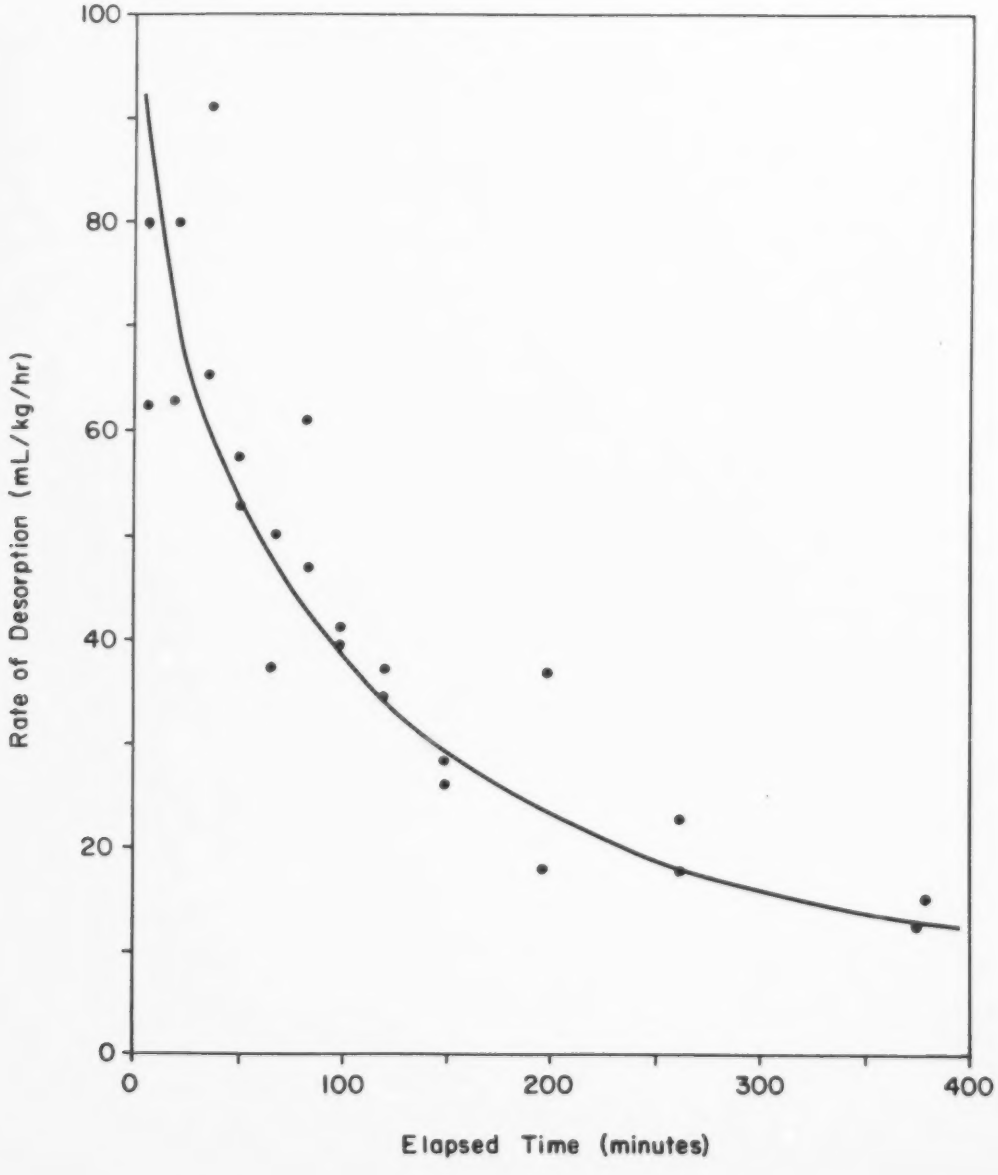

FIGURE E-13
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: F
Sampling Date: June 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

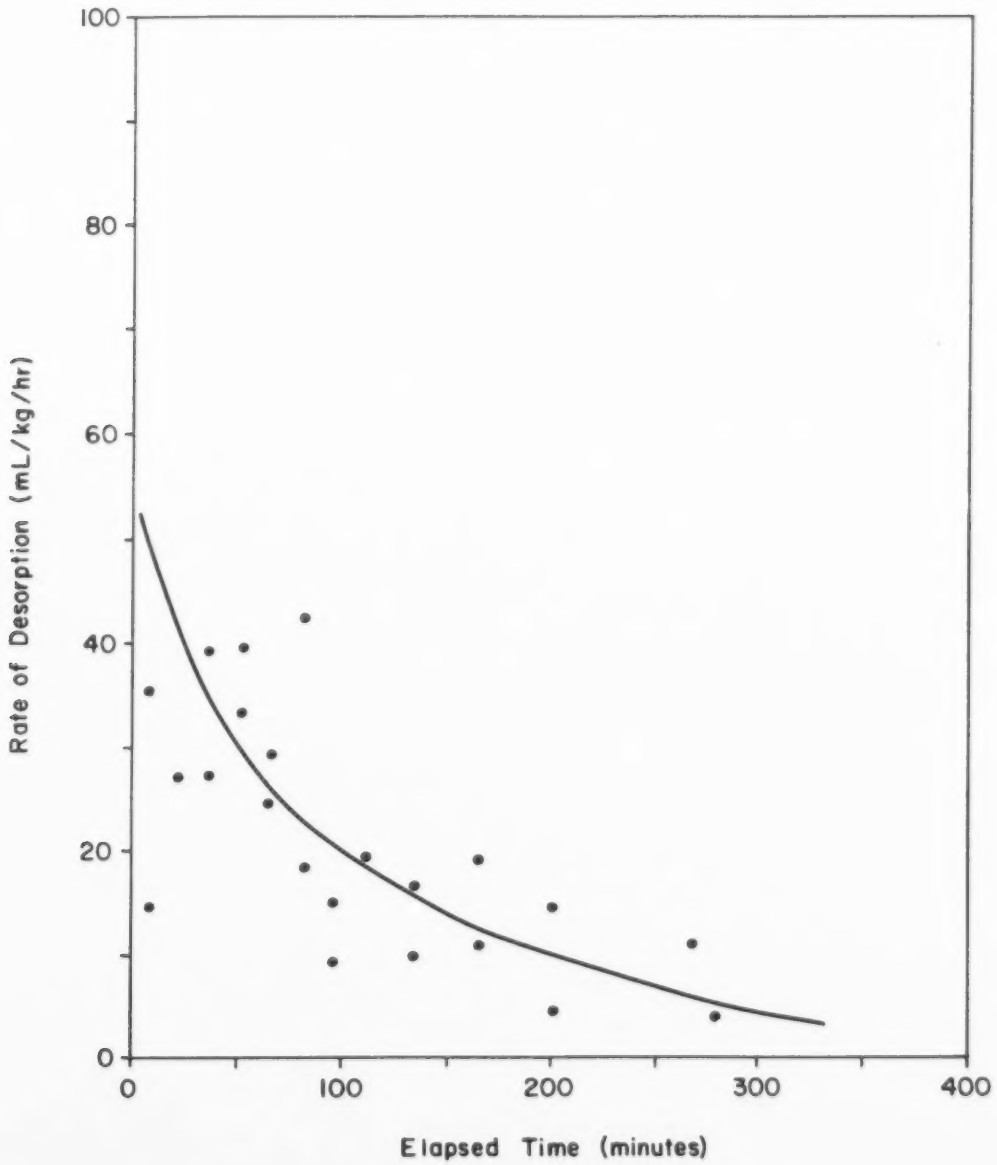

FIGURE E-14
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: F
Sampling Date: September 12, 1985
Coal Temperature: 42°C
Coal Product: Clean Metallurgical

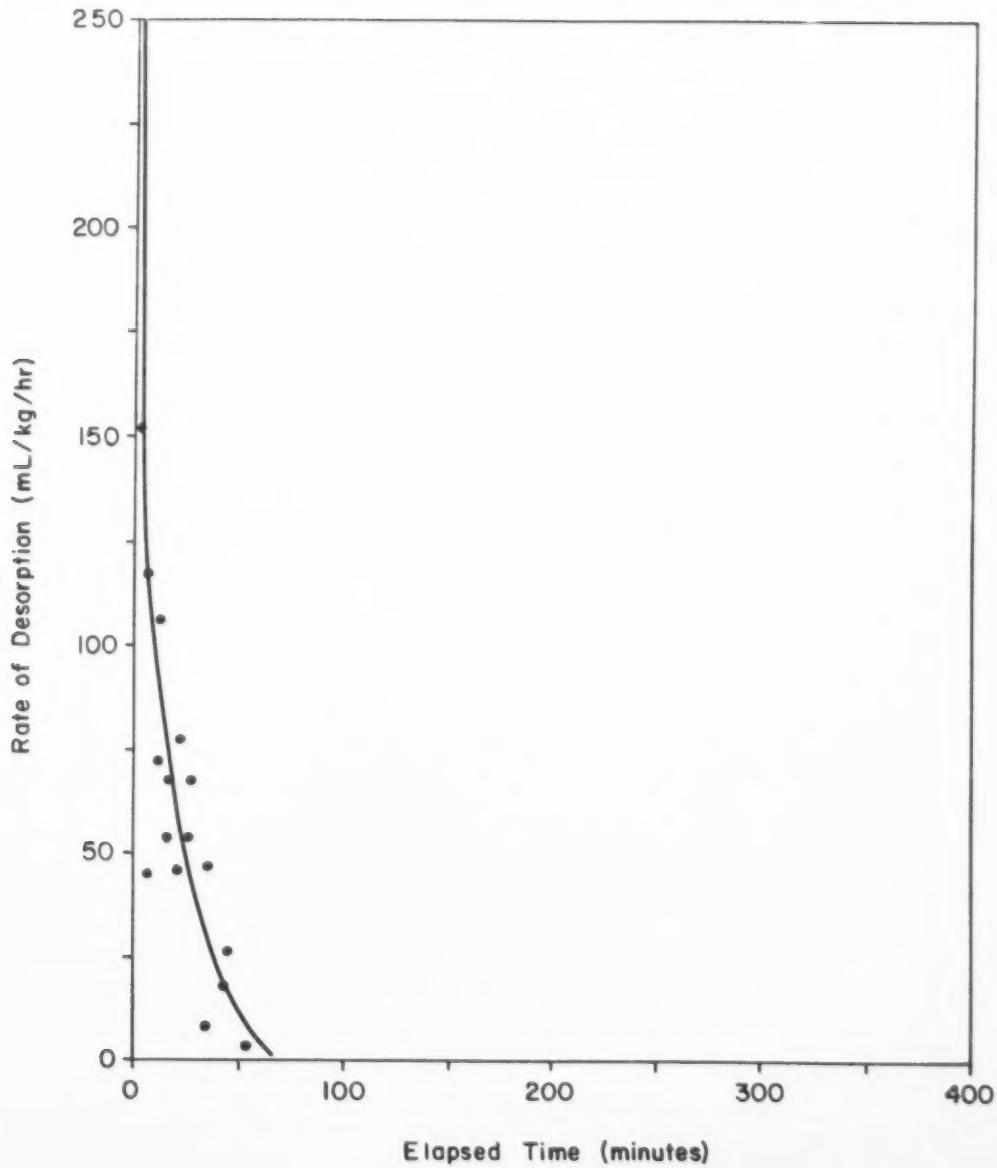

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FIGURE E-15
SURVEY OF METHANE ACCUMULATION
WITHIN COAL SILOS

RATE OF DESORPTION

Mine: H
Sampling Date: August 13, 1985
Coal Temperature: 20°C
Coal Product: Raw Metallurgical

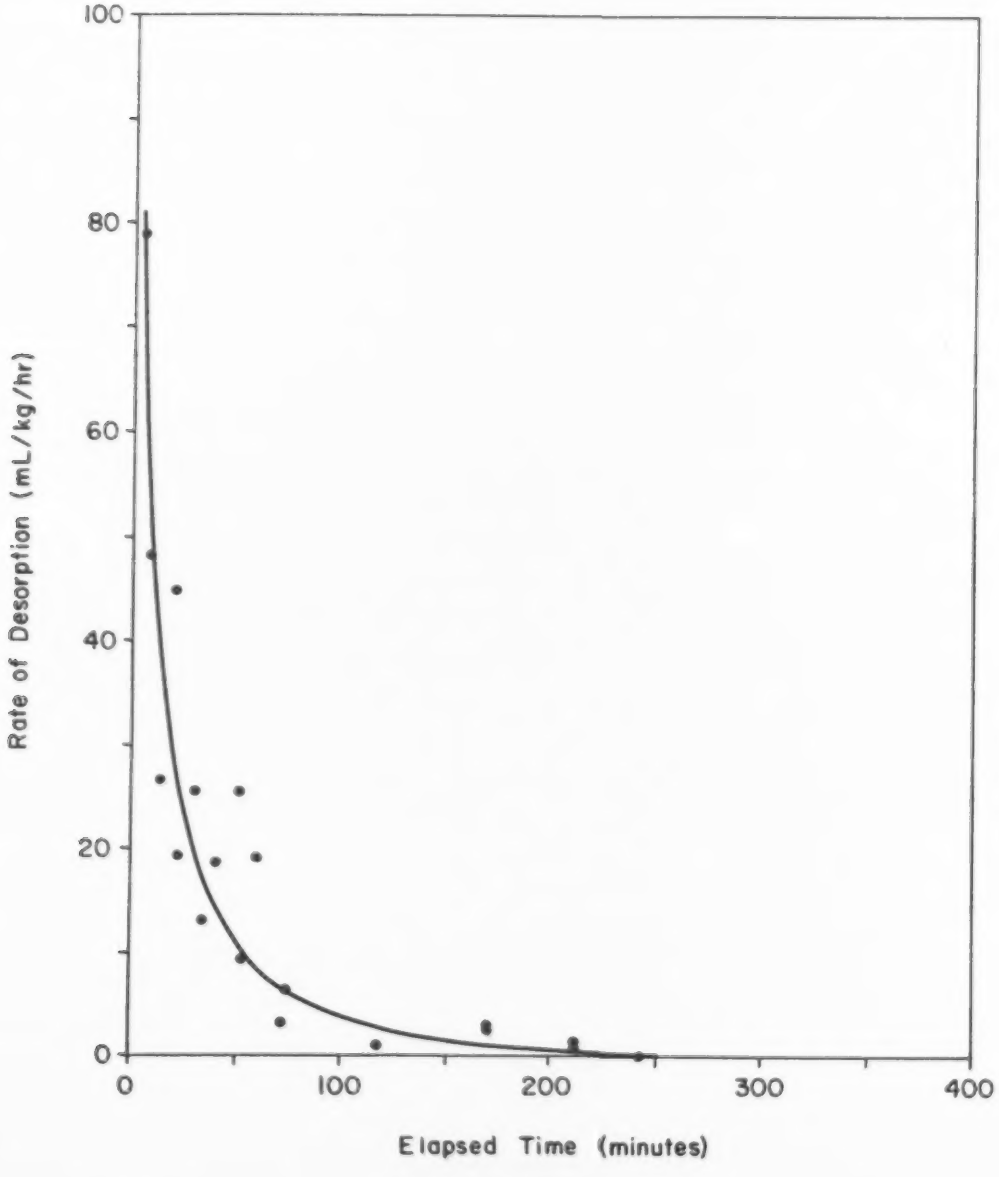

FIGURE E-16
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: H
Sampling Date: August 18, 1985
Coal Temperature: 32°C
Coal Product: Clean Thermal

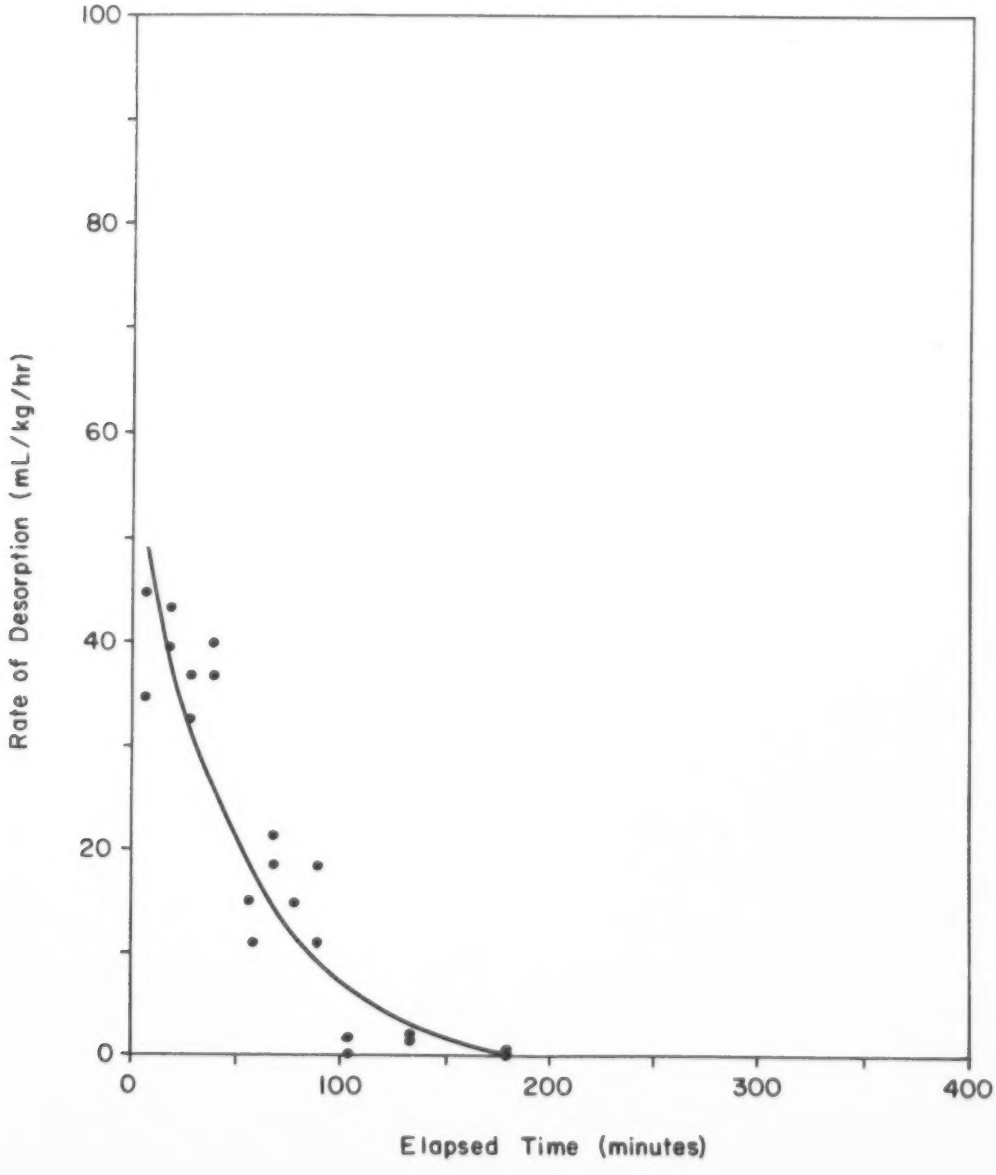

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FIGURE E-17
SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: I
Sampling Date: July 25, 1985
Coal Temperature: 27°C
Coal Product: Clean Metallurgical

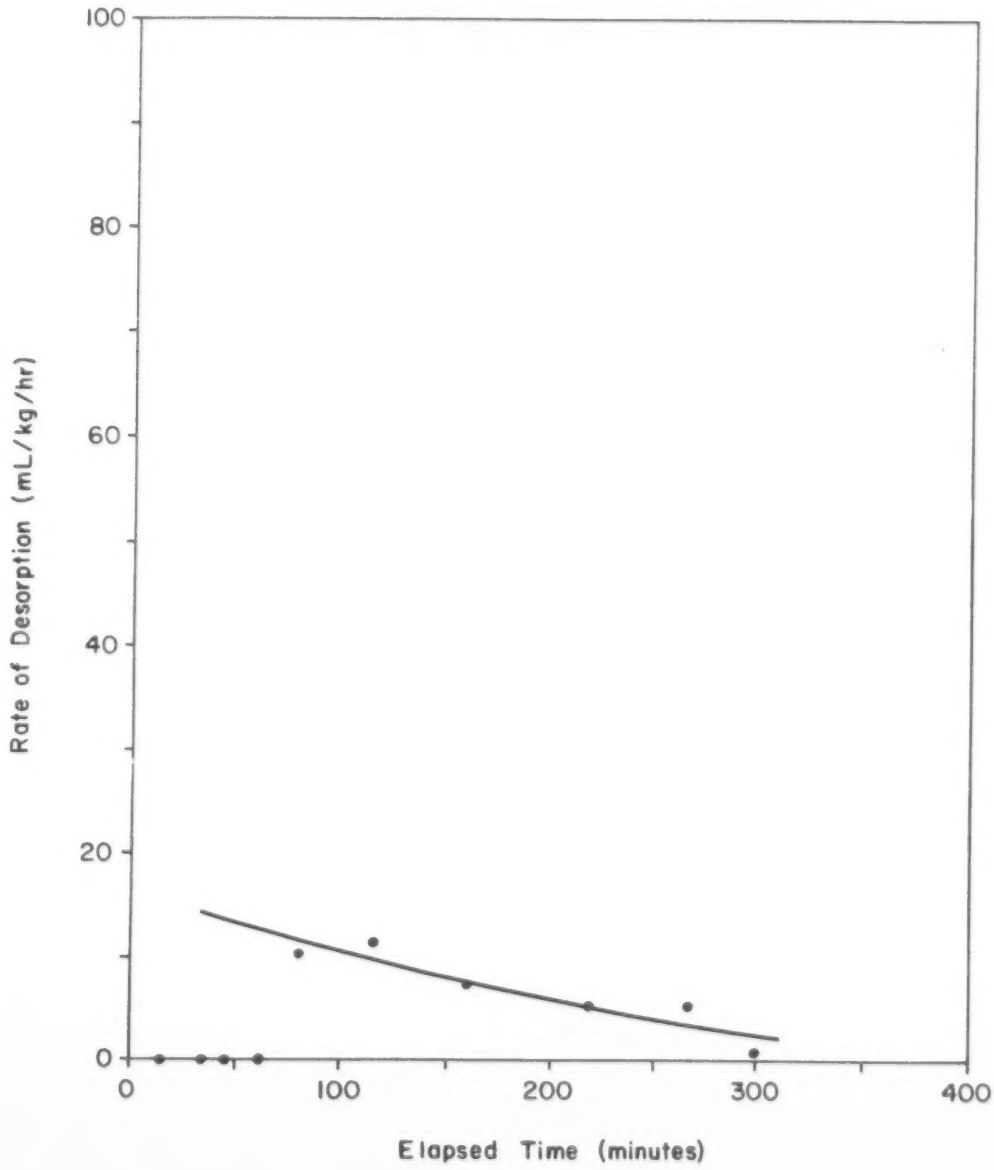
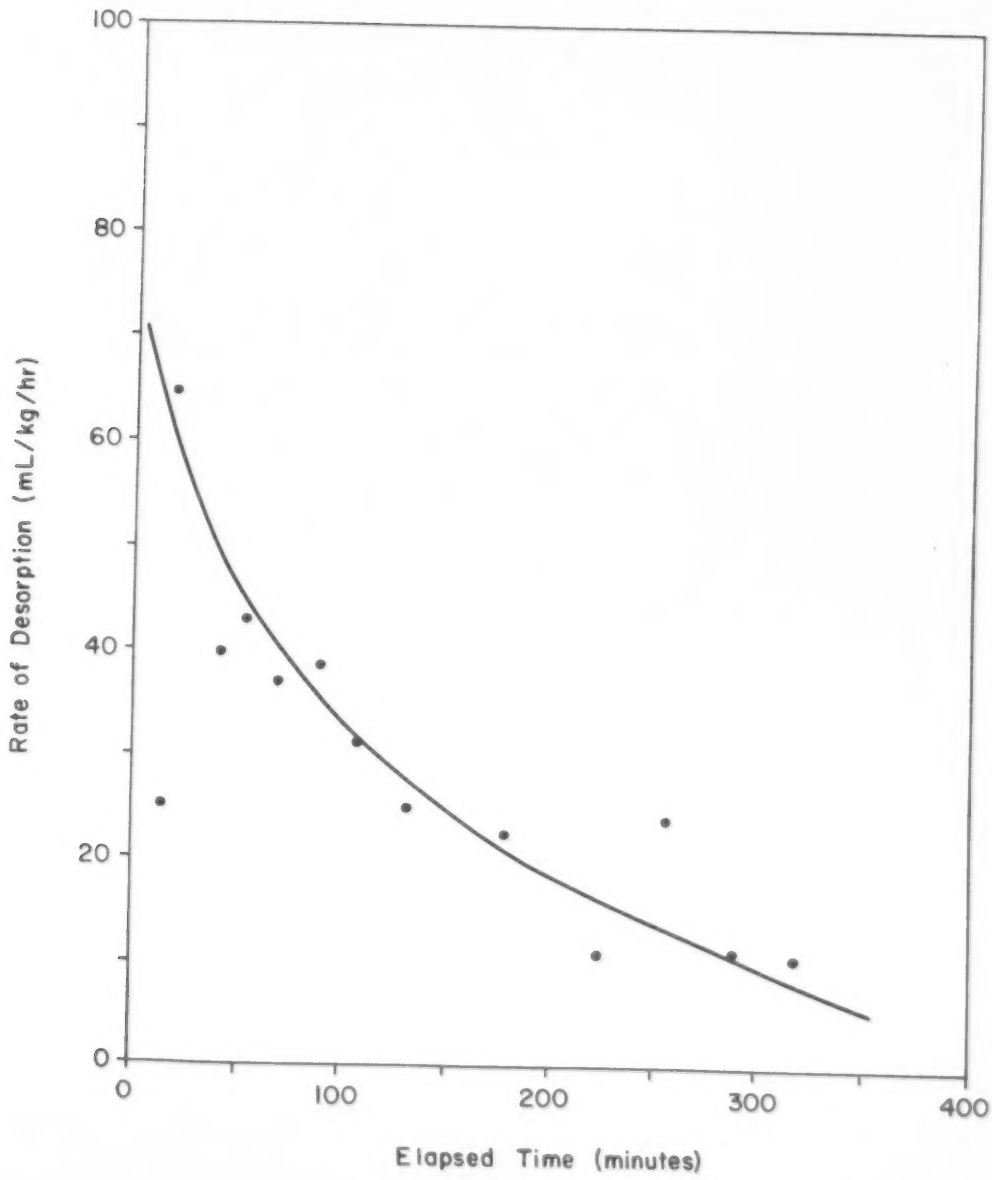


FIGURE E-18

SURVEY OF METHANE ACCUMULATION WITHIN COAL SILOS

RATE OF DESORPTION

Mine: I
Sampling Date: July 25, 1985
Coal Temperature: 18°C
Coal Product: Raw Metallurgical